

ASPECTS OF STRIP-CARTOON INTERPRETATION

IN 5 TO 7-YEAR OLD CHILDREN

BY

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I declare that this thesis has been composed by myself and that the work reported in it is my own.

No part has been submitted in support for another degree or qualification of this or other University or Institute of Learning.

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### Abstract

This study assesses 5 to 7-year-old children's ability to interpret strip-cartoons. It is carried out through an evaluation of responses to three types of tasks: 1- picture seriation tasks, 2- matching sequences of pictures with stories, 3- drawing sequences of events from a story.

This evaluation progresses in the following sequence: The first part of the study verifies certain basic requirements for picture ordering tasks, namely the dynamic and generative interpretations of single static pictures and children's ability to differentiate pairs of pictures and to interpret these differences in terms of transformations.

Secondly, and more importantly, this research evaluates children's performance with strip-cartoons (containing between two and eleven frames) representing various classes of transformations. It also attempts to appraise the effect of various types of difficulty on subjects' seriating performance and to find means by which the effect of some of these difficulties can be reduced.

Thirdly, a comparison between the performance of subjects to rod seriation and picture seriation tasks is carried out and the limitations of these measures are stressed.

Findings indicate that:

1. the majority of children between the ages of 5 and 7 years understand that a correspondence exists between the spatial order of a series of pictures and the order of succession of the events they represent;
2. they can relate two represented events in time;

3. the order of presentation of pictures influences subjects interpretation of sequences of events;
4. under a particular condition, subjects had less difficulty in tackling well differentiated frames than series containing similar frames because they tended to overlook details;
5. inserting intermediate events in a sequence to represent a story proved difficult for most subjects (under 7 years old);
6. drawing sequences of events was the most revealing method used to assess children's "potentiality" in strip-cartoon interpretation (and the understanding of the concept of order in this context);
7. subjects over 7 years of age did better than the younger subjects in the most difficult task;
8. picture seriation tasks are better understood than rod seriation tasks by younger subjects;
9. subjects use different ordering criteria to order series of pictures and series of rods both representing a change of size between elements.



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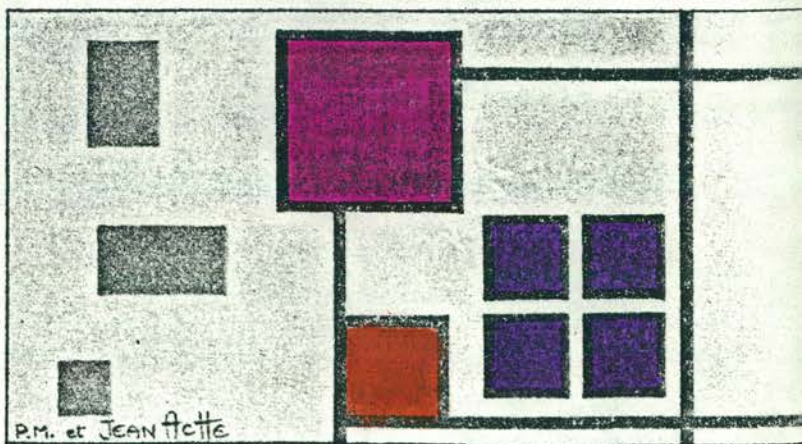
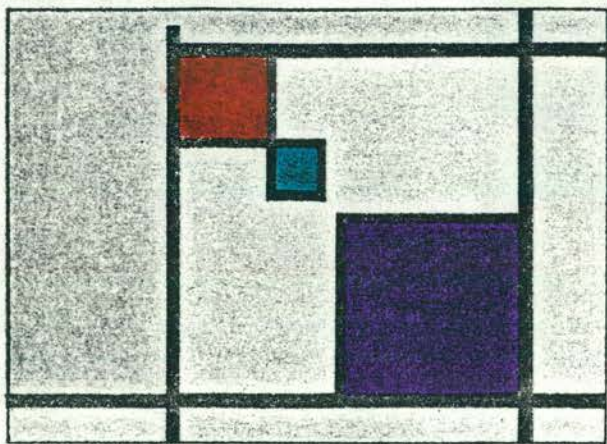
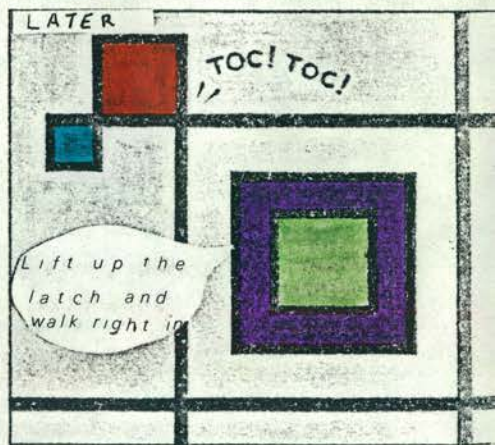
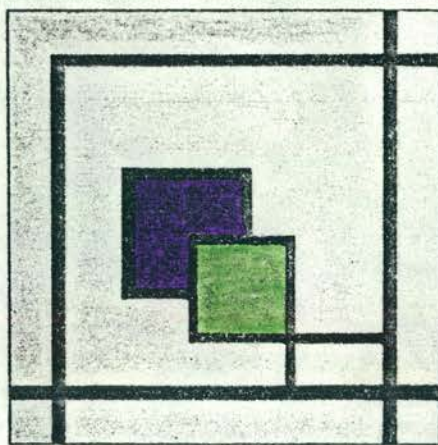
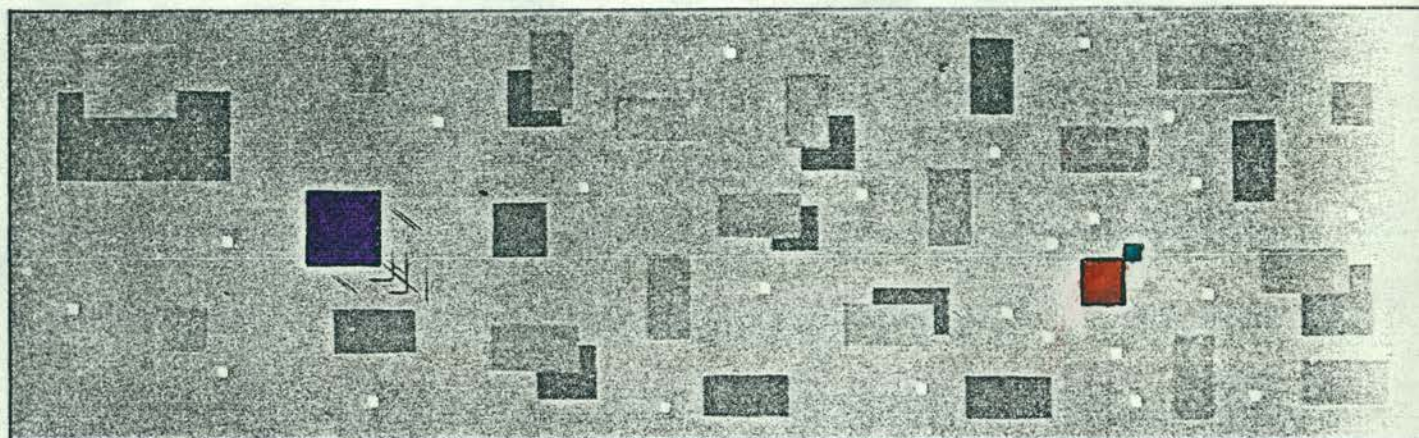
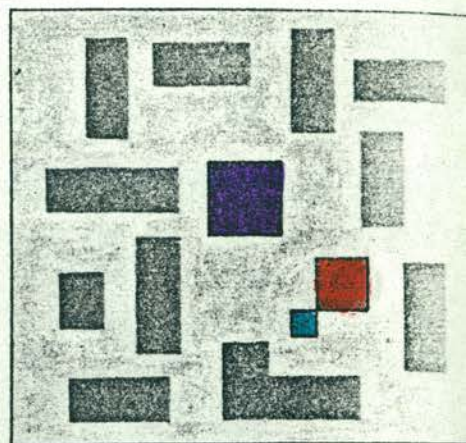
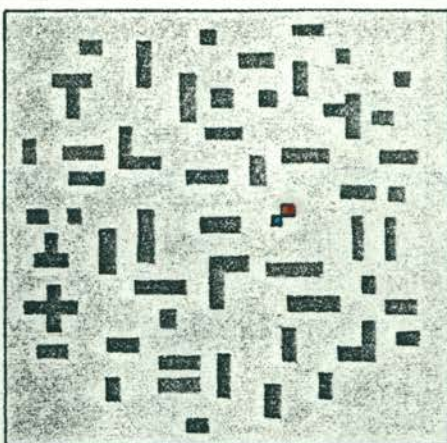
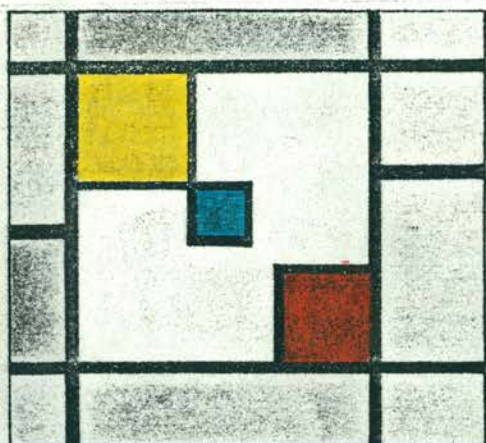
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### Prefatory note

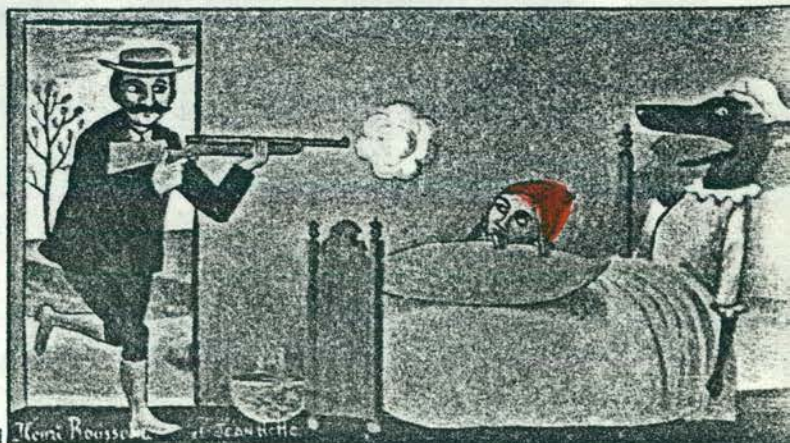
The material illustrated in this dissertation is presented in Black and White and the dimensions of the sets of pictures have been reduced in accordance with the format regulations of this thesis.

The sets of pictures presented to the subjects were composed of coloured pictures of homogeneous size.











## CHAPTER 1

### Introduction

The general aim of the present developmental study is to bring some light upon the acquisition of operational thinking by children between the ages of 5 and 7 years. The context chosen to carry out this investigation is that of strip-cartoon interpretation.

Many reasons justify this choice. Firstly, very little is known about strip-cartoon interpretation. Secondly, the extensive range of problem-solving situations available in this context allows us to evaluate simple low-level action perception as well as high level hypothetico-deductive reasoning. Thirdly, the natural interest which strip-cartoons arouse in children optimises the probability of obtaining from them the "involved" response which one needs in order to reach an understanding of their actual cognitive capability.

This introduction will be divided in four sections. In the first section (1.1) a profile of the 5 to 7-year-old child will be drawn. This profile will mainly be based on Piaget's theory of development concerning aspects of the child's behavior which are relevant to this study, i.e. the preoperational child's acquisition of the concepts of space, number and time.

The second section (1.2) will be devoted to the child's language acquisitions concerning these same dimensions of thought, i.e. space, number and time.

The third section (1.3) will discuss the Gibsons' perceptual learning theory according to aspects pertinent to this investigation.

The final section (1.4) will review a number of studies on children's picture processing strategies followed by an outline of

the questions this study is attempting to elucidate.

Before carrying out this plan of discussion, a justification of the developmental stage chosen for this investigation will be given.

According to Piaget's definition of the second stage of the preoperational period of development, children between the ages of 5 and 7 years are on the threshold of operational thinking. Since the purpose of this investigation is to learn about the process of acquisition of operations this stage of development appears as the obvious choice.

Furthermore, pilot studies showed that 4 year olds either could not justify their answers to a three picture seriation task or were very inconsistent in their choices. The unreliability of these subjects' answers suggested that older children should be tested in the remaining experiments (cf. appendix 1).

### 1.1 Preoperational child's profile

In Psychologie de l'intelligence (1947) and in l'Épistémologie génétique (1970), Piaget characterises the preoperational child's thought as intuitive or pre-logical, i.e. intelligence functions by intuitive regulations. The child proceeds by trial and error and corrects his judgements after he has made an error instead of planning a strategy which anticipates possible errors.

Piaget specifies two levels of preoperational thought. The second level (ranging from the age of 5 to 7) is characterised by the passage from a radical egocentricity to a relative egocentricity generated by "objectivation and spatialisation". This decentration



depends on progressive co-ordinations which take the form of functions. The child realises that because two variables are coordinated, the modification of one implies the modification of the other and one can assume at this point that the child is capable of real relations rather than pre-relations present in the previous stage.

However, these functions which Piaget qualifies as "constituantes" (constituting) rather than "constituées" (constituted) remain qualitative or ordinal rather than being effective quantifications; this is why they are an intermediate step between actions and operations. Indeed the function (constituante) is not reversible so does not comprise yet necessary conservations. For instance, the child is still influenced by the salience of the notion of order in the sense that a journey is "longer" if it ends "further" (independently of the starting point). The function expresses the child's dependence on action but is nevertheless directed towards logic (general coordination of actions) and causality.

As far as inferential compositions are concerned, such as transitivity, they are still not mastered according to Piaget. This failure of transitivity is exemplified by the fact that if the child sees two rods  $A < B$ , then  $B < C$  he does not conclude that  $A < C$  if he does not perceive them simultaneously. The same failure is seen in the domain of causality in the process of mediated transmission (e.g. children do not understand that when a marble hits a row of marbles and that the last one alone moves that the impulsion has gone through the intermediate marbles.) However, in cases of immediate transmissions (a ball hitting a box or another ball), the transmission is understood but the direction of the passive and active mobiles is still poorly predicted and explained.



Concerning children's ability to make transitive inferences, Bryant and Trabasso (1971) have claimed that children of 4 are capable of transitivity. According to them, the child's difficulty is more a matter of some process in memory than logical competence.

Trabasso and Riley (1975) propose a "linear order model" which explains how children could have produced inferential type answers. Piaget and Trabasso do not use the same criteria to define transitive inference and this is why we are faced with controversial affirmations. Trabasso does not believe that children make transitive inferences in a qualitatively different way than adults. This argument is sufficient for him to conclude that if children proceed in an adult way there is no point in classifying their behavior in a different category. Trabasso does not believe that transitivity requires the same logical prerequisites which Piaget claims are necessary and concedes that children do not produce transitive inferences as they are defined by Piaget. The whole issue seems to bear on the criteria established by the different authors to define transitive inferences. Nevertheless this divergence in definitions was not at all clear in the 1971 paper which stated "Contrary to the conclusions of Piaget young children can make transitive inferences if precautions are taken to prevent deficits of memory being confused with inferential deficits" (Bryant and Trabasso, 1971, p. 456).

In the last part of this section, the remaining facets of Piaget's preoperational profile will be accompanied with other authors' positions on the same topics.

## The concept of space

In the Piagetian framework, space is acquired in the following ontogenetic order: the child can discriminate on the basis of topological relations early in the preoperational period but projective and Euclidian geometries are only mastered around 9-10-years-old. The operational grasp of order (as well as notions of surrounding and enclosure) are not usually achieved before the early school years. As far as perspective transformations are concerned, the child manifests egocentric behavior, he has difficulty in dissociating his own point of view of a scene from the one which he is asked to reproduce or recognise in pictures. The child can recognise, however, objects presented from different viewpoints but to represent such a change necessitates a conscious awareness of a viewpoint together with the transformations induced in the perceptual object of this viewpoint. If a child is asked to reproduce in a reverse orientation relations of an object to the environment, at 5 years he notices the rotation but only succeeds by trial and error in reproducing the adequate arrangement.

Nigl and Fishbein (1974) using the same type of experimental task Piaget and Inhelder (1956) have called "co-ordination of perspectives" found that the ability to relate perceptually and conceptually left-right and back-front relationships simultaneously emerges between the ages of 4.5 and 5.75 years but that by 5.75 years perception is more advanced than conception. They also found a developmental shift between the ages of 9 and 11. The model they propose to account for their results identifies "extraction" of spatial relationships from the stimulus array and from the choice

stimuli and "comparison" and "matching" of the images derived from extraction as the fundamental processes involved in both perceptual and conceptual aspects of co-ordination of perspectives.

Concerning the similarity between figures, the child can directly perceive whether figures having different dimensions possess similar relationships. When the child is asked to ascertain the identity of a person or a plant over time, Piaget (1968) found that children could readily accept the identity if shown pictures of himself or the experimenter but had more difficulty in accepting the identity of a plant when differences in growth were greater (e.g. the child had difficulty in accepting that the same shrub had become a tree). However, the child of 5 could correct his error if questioned on his answer.

Constancies prefigure conservations in the sense that both rest on the same functional process of compensations: in both cases, variations of certain properties compensate one another and assure the relative or absolute invariance of the whole.

Perspectives along with visual constancies are acquired perceptually in the first year of the child's existence while they are not organised as operations before 7-8-years-old.

In the context of this study the child will be asked to construct a sequence with series of pictures. He will therefore need to perceive similarities within pictures of the series to perceive the continuity of the sequence. On the basis of Piaget's observations, it is expected that subjects will not encounter any difficulty in accepting the identity of objects undergoing transformations.



On the basis of Piaget's theory on the child's acquisition of certain space concepts and on the basis of Nigl and Fishbein's findings concerning children's co-ordination of perspectives, it appears probable that the youngest subjects to be tested in this study could find it difficult to co-ordinate frames in which the portrayed relations are represented from different perspectives.

#### The concept of number (seriations)

To continue the preoperational child's profile, let us now turn to the question of seriation and see where 5 to 7-year olds stand relative to this type of strategy. Piaget (1952) argues that to seriate operationally is to co-ordinate the two inverse relations  $s < r$  and  $s > t$  (the ability to consider an object as being at the same time smaller than another and bigger than another) and this implies the possibility of setting out the series in either direction. The preoperational child's usual habit of proceeding in a trial and error fashion is manifested once again in seriation tasks. No systematic procedure is adopted to complete this type of task and when the child is asked to make a correspondence between two groups of objects of increasing sizes, he tends to rely on the optical correspondence.

Brainerd (1973), Bryant (1972) and Siegal (1974) found with Piaget that cardinality is not understood by young children since they base their judgement on lengths rather than on one-to-one correspondence. Siegal argues that the young child (between 3 and 5-years-old) has difficulty in separating and co-ordinating the dimensions of length and number. Brainerd (1973) has argued that the development of the understanding of concepts which involve the ordering of quantities precedes the development of class or

cardination concepts of number.<sup>1</sup>

Bryant (1972) working on the invariance principle argues that the child's ability to make a consistent choice depends very much on what display he is given; sometimes he uses the correct cue, sometimes the wrong one. He is incapable of deciding which criterion (length or one-to-one correspondence) is the better one to judge the equality of rows, so depending on the display he will use either one. He often uses length of rows instead of the one-to-one correspondence.

Elkind (1968) says that when the child is shown how to make a staircase with rods, he tries to reproduce the one the experimenter has just made and ends up by getting it right using his mental image of the proposed staircase. However, if the child is given extra rods, he cannot fit them in the series because for him these extra rods do not belong to his first mental model of the staircase, (i.e. the one made by the experimenter).

Werner (1957), in his Comparative Psychology of Mental Development argues that the young child tends to conceive a group as a naturalistic situation in which the single elements are embedded

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<sup>1</sup>Brainerd found three stages in the emergence of the cardination concept: in the first stage the child confuses number and length (longer means greater numerosity). In the second stage classes of equal length but different numerosity or different length and numerosity can be judged correctly, however, in stage 2 children cannot perceive a one-to-one correspondence where numerically equivalent sets are of different lengths. In the last stage the cardination concept of one-to-one correspondence is understood.

and from which they get their meaning. To exemplify his claim he reports an observation by Muchow: children asked to order circles of different sizes were naming the circles mother, father, children... as they went along ordering them. The circles were not ordered by size alone but rather according to size within the family. Later, Werner reports Weigl's conclusion that in ordering experiments with pre-school children, grouping occurs not in terms of abstract signs but rather according to participation in a concrete collective situation (p. 228).

A further discussion on the problem of seriation will follow later on when the problem of "picture seriation" as such is tackled.

#### The concept of time

The following part of this section will complete the account of the preoperational child's profile with considerations on the concept of time.

Piaget (1946) believes that the child initially confuses successions of events in time and the temporal intervals these successions generate with their equivalent in space, i.e. the succession of points traversed and the spatial distance between the points.

When the child deals with one motion he succeeds but with two at once, with different velocities, he makes errors. Thus, the time which needs construction is the one which constitutes a co-ordination of movements of different velocities in a common temporal framework.

Temporal order, simultaneity and duration are very poorly coordinated notions for the preoperational child.

Fraisse and Piaget examining children's ability to organise a series of pictures representing moments of a continuous process



such as water flowing from a container into another found that young children fail in deciding the correct order because instead of directly perceiving the movement of the water from top to bottom, they see nothing but static relationships (or static levels) to which an order must now be given. They must reconstitute this order by deduction in the form of a temporal succession.

Piaget sums up by saying that the progress of a child towards temporal seriation of events is marked by the replacement of the stage of perception by the possibility of constructions on the level of representation although they still remain intuitive. At a later stage still, the child actually understands order because he is capable of using all the facts of the situation, acquired knowledge, causal relationships and in particular, the durations between events in an operational construction.

Lovell and Slater (1960) studying the growth of the concept of time through similar experiments to the ones designed by Piaget found relatively the same types of behavior as Piaget.

An interesting experiment by N. Van Den Bogaert-Rombouts is reported in l'Epistémologie du temps (1966). This experiment entitled "Perception spatiale d'une série temporelle" evaluates children's ability to understand the correspondence between the alignment of a series of counters and the temporal succession of displacements of a mobile (A). The second part of the experiment evaluates subjects' ability to find a strategy, using the counters, to reconstitute the succession of displacements of the mobile (B).

(A) The experimental procedure goes as follows: five small houses of different colours are positioned randomly on a table. A counter is placed in front of each house. This counter

is of the same colour as the house. A toy lorry goes from one house to the other picking up the counters. These counters are lined up in the lorry in the order in which they have been picked up. The child is asked why the counters are lined up in such a way in the lorry.

At 5 the child is conscious that a link exists between the alignment of the counters in the lorry and the succession of displacements of the lorry (between 60-68% of children can explain the relation).

(B) In this second part of the experiment, the experimenter once again moves the lorry between the houses without picking up the counters. This time the child has the counters. He is asked to find a way in which he will be able to reconstitute the lorry's journey. Only at 7-8 will the child be able to use his knowledge in a practical way and reconstitute the order of succession of displacements with the counters.

The fact that the child is allowed to perceive the construction of the spatial seriation while witnessing the sequence of events might explain why he readily accepts the correspondence between the two seriations. In the second part of the experiment (B) and in the previously described experiment (Fraïsse and Piaget and the connecting containers), the child is asked to construct the correspondence between the two seriations (temporal and spatial) which means that he has to look for a strategy or a rule of correspondence.

The fact that the child fails in producing this strategy demonstrates that he cannot completely master the rule of correspondence. The incomplete integration of this rule is also



evident in Piaget's work on the concept of number. It has been seen earlier that even though the child accepts the invariance of collections when a one-to-one correspondence is evident, he becomes very uncertain when the optical correspondence is no longer obvious.

In the context of the present study, a pre-test was carried out with a number of subjects. This pre-test also confirms the child's ability to produce a correspondence between a series of witnessed events and their spatial representations. The pre-test consisted in observing a number of actions executed by the experimenter and then pointing out the pictures representing these actions in their order of execution. Children were also able to display pictures in the left-right order provided they had been taught this convention.

Fraisse (1966) reports an experiment he performed with children (between 5.6 and 14-years-old) on their estimation of duration (*estimation de la duree*). The purpose of this experiment is to show the importance of the frequency of changes on the child's evaluation of durations as opposed to the simple notion of speed. The test involves two sessions of slide projection. These sessions vary in number of slides and time of projection of slides. In one condition twice as many slides as in the second condition are presented but they are presented for half the time so that both sessions last the same length of time. The child is asked to compare the length of both sessions. Young children's answers (6 years old), when justified, involve only one criterion which most of the time is the number of changes in the projection. As the child develops, he can use more compensating criteria: "there are more pictures but they appear for shorter times."

Considering the concept of time from another angle, Ames (1946) and Werner (1957) emphasize the egocentric aspect of the child's concept of time and its rigidity. They demonstrate how the child's own experience and preconceptions are important in his conception of time. Werner noticed that for the child, time is undifferentiated from the cues that specify it. For instance, if for the child flowers mean summer, at the sight of flowers in the garden he will immediately conclude that it must be summer. Time is also thought of as objectively discontinuous, for instance if the child knows that summer starts on the 21st of June and that summer is a hot and sunny season, he will expect the first summer day to be sunny and hot, he does not allow for progressive transitions. Werner concludes by saying that the child's concept of time is based on an egocentric and concrete mode of experience and it tends to develop steadily toward a universal scheme. For Ames, the temporal concepts of the preschool level are primarily related to the personal aspects of before and after with reference to simple schedules and appropriate tenses in linguistic intercourse.

## 1.2 Language acquisition

The second section of this introduction will report studies concerned with the linguistic acquisition of concepts analysed in the first section. An effort will be made to link cognition and language.

### Seriations:

Children's verbal responses to situations involving seriations were also studied. Inhelder (1969) reports a study by Sinclair where she obtains results in terms of verbal responses



that parallel the stages of the rod seriation task. She finds that the youngest children use two descriptive terms, i.e. long and short to describe successive pairs of sticks, slightly older children use three, while even older preoperational children use comparatives: "short, longer, longer". However, when asked to describe the series starting at the other end of the series, they were unable to do so. The children seemed to be unable to describe a rod they had just called longer as being shorter. According to the authors, the lack of reversibility would seem to extend to the verbal descriptions as well.

#### Space:

From the point of view of spatial relations, studies were made to see if children developed linguistically in the same way they acquired spatial notions. Parisi and Antinucci (1970) proposed the order of acquisition of three types of locatives based on the Piagetian order of acquisition of spatial notions. The locatives are the following: "in" and "on" which can be described in terms of topological notions, "in front of", "below", and "beside" which emphasize dimensional space notions and "along" and "through" which are more complex spatial notions.

These investigators found that (Italian) children had the least trouble with words indicating simple topological concepts, slightly more with locatives concerned with Euclidian space and even more trouble with terms encoding complex spatial notions.

Brown's numerous studies on the child's acquisitions of language show that at the very earliest stages of language acquisitions, children seem to have acquired only the prepositions

which refer to the simplest relations, those to do with topological relations. It even seems that children are expressing these relations in their two word utterances even before they have acquired the particular prepositions which encode them.

Clark (1973) claimed that young children rely on a combination of linguistic hypotheses about the word meanings and certain non-linguistic strategies to comprehend in, on and under. The non-linguistic strategies amount to a sort of response bias, a preference for behaving towards certain objects in a certain way (e.g. when under is used with the command: "put something 'under' the table", children tend to respond as if the command had been "put it on the table"). Depending on the object used, children interpret on, in under differently, sometimes well, sometimes wrongly. Yet at 3 years of age the child seems to master the meaning of these words.

Since these spatial notions develop at a quite early stage of the child's development one would expect 5 to 7-year-old children to have no difficulty in describing spatial relations in pictures. Some pre-experimentation, in the context of our study, was done to confirm that children could express correctly some spatial relations when pictured from different angles and results agreed with the prediction that children could describe spatial relations independently of the point of view from which the scene was portrayed (behind, beside, in the middle of...)

Time:

Another aspect of linguistic acquisition which is very relevant to this study is the ability of children to use "time words" or understand temporal notions. Cromer (1968,1974) found that the



understanding of certain temporal notions precedes the acquisition of linguistic forms proper for their expression. He studied utterances of two children from the age of 2.25 years to 6.15 years. In the early stages children's utterances relating two points in time preserved the occurring order of events, only at 4 did children begin to reverse these relations occasionally (e.g. "d'you know the lights went off" (present-past), "look what I found" (immediate-future-past)); however, the use of before and after was rare. The Clarks (1970-1968) found that 3.5 years old retain the actual order of events in time in their spontaneous speech and this form of order was also preferred in memory experiments as well as manifest in the child's expression of sentences.

Ferreiro and Sinclair (1971) noticed children's inability to reverse linguistically the order of two events in time. The experimenter presented the subject with some actions carried out on dolls. The child was asked to describe the actions but starting with the second action first. The youngest children (4.5 years old) either repeated the original description which retained temporal order (i.e. they did not follow instructions) or complied with the instructions not supplying any temporal indicators (e.g. he did this and she did this). At 5.5 years of age children complied with instructions but were incapable of using correctly the temporal indicators. When they did use them, they would reverse the order of events as well. Other inadequate solutions were given by the subjects, such as reversing the action (e.g. instead of going up, they would say coming down) or inverting the actors (e.g. instead of the girl washed him they would say the boy washed her...) However, children knew perfectly well which event had occurred first or last but were

unable to code this reversibility linguistically. The authors conclude that "syntactic transformations are not yet integrated into a system which permits the conservation of the entire semantic content."

Cromer in his longitudinal study of the two children (1968) was also concerned with statements of a hypothetical nature which are based on the ability to move one's point of view about in time. For example in "if it rains, I will take my umbrella", the possibility of rain is taken as a future event which, if it occurs will result in the even later event of taking the umbrella. Hypothetical and counter-factual statements (as in "if you had telephoned I would have come to your aid") require complex cognitive abilities which include the ability to refer to "possibilities" as well as to change one's vantage point in a time sequence. Cromer found that it was not before 4.5 years of age that the "possibility" emerged as a category in regular use (e.g. "I bet I could play it", "think cows would like this...") and that hypotheticals also began to be used (e.g. "if you keep on going, it's gonna get bigger on this side and bigger on that side, right?").

Slobin (1966), studying children's acquisition of Russian, found that even if grammatically the hypothetical is easy it was not used by children before quite late and he concludes that it is the semantic and not the grammatical aspect which is difficult for the child.

The next notion to be examined by Cromer is "timeless utterances" referring to the child's cognitive ability to take some action or event which normally occurs at some point in time and lift it out of any particular situation and so imbue it with a timeless quality (e.g. "playing a banjo is a good exercise for the thumb").



This type of description was present in the two children's speech at 3.15 years.

These findings support the assumption that cognition precedes language and determines its acquisition. The fact that many temporal features (some of them have not been mentioned here) emerge sometimes after 4.3-4.5 years of age might suggest the existence of a cognitive ability which becomes active and permits the expression of several new types of temporal reference. What these temporal references seem to share appears to be the ability to free oneself from the immediate situation or from the actual order of events in time. It is as if the child was able to de-centre his viewpoint to approach a temporal sequence in other than real sequential order. This would be, concludes Cromer, a basis for the reversals which emerge at this age. The freedom from the actual order of events in time would permit the child to place himself at other perspectives and thus consider events which are contingent on future possibilities.

If children are actually de-centred at the age of 4.5, i.e. when they have acquired the proper use of different types of temporal reference and on the basis of what Cromer says the use of hypotheticals implies in cognitive abilities, the prospect of the quality of children's performance in strip-cartoon interpretations should be fairly bright. Since a child can make statements of a hypothetical nature, it is probable that he has a certain power of prediction, i.e. it can be assumed that given a picture representing an event, the child could predict the outcome of the pictured event and maybe the outcome of this second event, but how far in time this power of prediction extends is still to be seen. One of the

cognitive abilities needed by the child to make hypothetical and counter-factual statements is "the ability to refer to possibilities as well as change one's vantage point in a time sequence". Can this ability which Cromer infers from children's utterances be extended to children's ability to envisage, given a picture representing an event, a variety of possibilities as to the outcome of this represented event? The ability to refer to possibilities is of course an essential prerequisite for making predictions on the outcome of pictured events. What is also essential is that the subject is able to make another hypothesis on the order of a sequence if he realises that his first hypothesis cannot account for all the information pictured in a sequence of pictured events. He has to decentre from his first hypothesis and use the cues to find the most plausible order of a sequence.

It is not assumed in any way that Cromer would predict these questioned abilities on the basis of his findings on the children's use of hypotheticals. However, if children manifest such cognitive abilities in language and if these linguistic abilities depend on cognitive abilities, they should also have the effect of helping the child to interpret strip-cartoons. It was said beforehand that the child's ability to express hypotheticals might be a necessary prerequisite in interpreting sequences of pictures. However, this ability is not a guarantee of success in producing adequate picture serialiations.

Earlier Cromer said that what temporal references seem to share was "the ability to free oneself from the immediate situation, to decentre one's viewpoint to approach a temporal sequence in other than sequential order." In 1971, he reported an experiment on the



development of the ability to decentre in time and found that children showed little decentred response at the age of 3 and 4-years-old. Between 5 and 6-years old this ability improved to a level of 40% of non-decentred response and after 6-years-old only 7% of responses remained centred. The child's task was either to choose from a series of pictures (representing a sequence of events) the one in which the actor could be making a particular comment, or to make comments referring to other points in time when asked to identify oneself with the actor of a particular picture. As one can see, decentration in this type of task is manifest in children over 6 years of age and not at the age of 4-5 years as Cromer proposed earlier on. The child seems to show abilities in his spontaneous speech which are not so obvious in certain tasks. There are problems of different levels of complexity and the fact that one has capacities to solve a simple problem does not necessarily mean that the same capacities are sufficient to solve a more complex problem even if both problems require the same type of cognitive abilities.

### 1.3 The Gibsons' perceptual learning theory and some criticisms of it

The following section will contain a brief account of the Gibsons' perceptual learning theory and findings, along with positions held by other authors on some of the topics covered in this account. The last part of this expose will assess the implications of these reported findings for the present study.

The construction of constancies and identity exposed earlier on from a Piagetian viewpoint is a corner stone of J. J. Gibson's theory (1966). Gibson grants an important position to the formation of invariants in his theory of perception and claims that

an observer learns with practice to isolate more subtle invariants during transformation and to establish more exactly the permanent features of an array. Perceptual learning is conceived as a process of "differentiation" by the Gibsons (1955). The observer learns to look for critical features, his attention is educated to attend to the information in available stimulation. As well as increasing the observer's discernment, practice also increases the span of attention over time and space, i.e. the system detects progressively larger forms composed of smaller ones and progressively longer episodes composed of shorter ones.

It is essential that children recognise some invariance through transformation in order for them to perceive the continuity of events. For the Gibsons, this is achieved by the child's learning to attend to critical features of objects, for Piaget (as argued by Gibson, 1966) it is achieved through the construction of reality. Both theories see experience and exploration of the world as necessary ingredients for this achievement.

The Gibsons' theory of differentiation was substantiated by a number of experiments. Some of them will be cited here because they bear on problems relevant to this study.

In learning to read, E. Gibson (1962) claims that the child has to isolate and focus on the features of letters that are both invariant and critical for rendering each one unique. She did an experiment putting letter-like shapes through different types of transformation in order to see if children could recognise differences between a standard and the transformed symbol. She assumed that some changes were easier to see than others and that errors made with these types of change (break and closure, rotation,

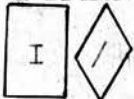


line to curve) would drop fast (from 4 to 7-years-old) because such differences were critical for letter discrimination. However, changes which are not critical for object identification, such as perspective transformations, would produce errors with all age groups (for example, it is important to see break and closure type of changes in order to recognise the difference between o and c. Children could cope fairly well with this type of change, however, a change in the tilt of a letter-like shape is difficult to see by all children because this type of change is not critical for letter identification).

Rosenblith (1965) found that certain figures do not "behave" in the same ways as others. She goes on to stress that: "this might indicate that caution is in order when interpreting the effects of a standard set of transformations on a variety of stimulus figures. The effects of a transformation may depend on stimulus characteristics of the figure to which it is applied." She produces one of Gibson's (1962) results to substantiate her advice. Gibson's results showed that left-right reversals were as frequent as up-down reversals while Rosenblith's results show that up-down reversals produced less errors.

Bryant (1971, 1974) does not agree with Gibson's explanation of why young children have difficulty with orientation transformations. Gibson claims that older children only succeed because it is a critical feature in discriminating letters, while at a younger stage children do not need to master this type of change. First of all, Bryant claims that orientation is an important information to the immediate perceptually-guided behavior of very young children (e.g. since young children pile up bricks they must perceive the

orientation of bricks). His second argument is that Gibson's display is too complex and that the child can no longer make direct comparisons between each choice figure and the standard. He has to commit the standard to memory before he begins to search through the choices.

Bryant (1969) proposes a "match-mismatch code" to explain children's behavior towards orientation discrimination, i.e. children can succeed if they find a framework to match the stimuli they are asked to discriminate (  ). However, such a limited code would not help schoolchildren in their reading, concludes Bryant.

Fellows and Brook (1973) tested some of Bryant's hypotheses. Their results failed to substantiate Bryant's finding that the presence of a coloured diamond framework facilitates the discrimination of obliques and they conclude that the main factor influencing the difficulty of the discrimination was the absolute orientation of the line stimuli and not the presence or absence of matching lines in the immediate visual field.

Bryant (1973) again concerned about the orientation discrimination, claims that children can use "relative codes" to remember something about a specific stimulus, i.e. when they compare two things presented separately, by connecting them to some common feature they make perceptual deductive inferences. They can make those inferences when comparing orientations fairly early (4-5-6-years-old) according to Bryant.

On the topic of orientation transformation, it is difficult to have a clear view of its role in the young children's perception since different studies (many of which have not been referred to here) come with different conclusions. Some studies claim that



children under 6 years of age are relatively insensitive to orientation differences while other investigators report that children discriminate between different orientations of the same stimulus fairly easily. McGurk (1972,1974) showed that without exception the disoriented form of a realistic figure was correctly identified whether that form was inverted or at  $90^{\circ}$ . Similar results were obtained for an abstract figure. Thus, children had no difficulty in discriminating between stimuli differing in orientation alone. In another condition children were asked to match a number of figures varying in size, colour and orientation to a standard one (abstract and realistic figures were used). Subjects judged the identical variant and the two variants which differed from the standard in orientation, all to be equally similar to the standard.

In the first reported condition McGurk established that these subjects could perceive differences between orientations of the same figure, yet in this condition there was a failure to discriminate between different orientations in terms of similarity to a standard figure. McGurk's thesis is that the important variable in such studies was the extent to which experimental conditions elicit attention to orientation as a discriminative cue. He argues that young children were capable of discriminating orientation but that this was a stimulus dimension of relatively low salience.

Let us now return to Gibson's perceptual learning experiments. In a learning experiment E. Gibson (1955) tried to teach children to discriminate between stimuli differing in number of coils, degree of compression of coils and orientation. She found that errors depended on the number of stimulus differences or variables by which an item differed from the standard. Errors were greater for less

change. By attracting attention to the differences, she found that children learned to say the same to a much smaller number of items.

Pick (1965) tried out two methods to improve children's discrimination of form checking two hypotheses; the first one being that the improvement depends on learning prototypes or images of each form and the other being that improvement depends on learning how forms differ. She concluded from her experiment that learning the dimension of difference is important for improvement in the discrimination of visual forms. The learning of a prototype was not the sole or the essential process for improvement of discrimination.

In another experiment, E. Gibson (1963) tried to show that similar changes are more difficult to recognise depending on the familiarity of the distinctive features. In the discrimination experiment subjects were presented with cartoon drawings which resembled profiles of faces in one orientation and writing in another.



Profiles are characterised by distinctive familiar features while in the other orientation the stimuli showed no such familiar features. It is on the basis of this difference that Gibson explains the less numerous number of errors for the profile pattern.

What emerges from Gibson's findings is that children have less difficulty in recognising stimuli when the number of variables by which they differ is greater, that teaching differences between stimuli helps discrimination rather than simply learning prototypes, that certain types of letter transformations are more easily perceived if they are critical in the discrimination of letters and finally that symbols which possess familiar distinctive features are easier to recognise through transformation than similar ones



presented in an orientation such that they lose all meaning for the subject.

What derived from Rosenblith's findings was that stimulus characteristics should be taken into account when predicting children's reactions to various classes of transformation.

On the topic of orientation, Bryant claimed that young children could discriminate between objects in different orientations as long as they found a framework to match the stimuli they were asked to discriminate. However, Fellows and Brook's findings did not confirm Bryant's theory. On the other hand, McGurk argues that children's behavior toward orientation depends on the experimental conditions, i.e. if they elicit attention to orientation as a discriminative cue. Overall he found that orientation is a stimulus dimension of low salience.

#### Implications of these findings for the present study

The evidence reported in this section demonstrates the importance of the experimental procedure used in collecting data as well as the importance of the type of stimuli presented to subjects. These remarks find support in the variety of results obtained with experiments on orientation transformations but they probably hold for other classes of transformations as well.

If a comparison is made between the material and procedures used in the experiments reported above and the ones to be used in the present study, it appears very plausible that strip-cartoon material will facilitate young subjects' interpretation task. The reasons for this predicted facility are many.

First of all (our) strip-cartoon material represents

concrete, familiar, meaningful objects embedded in a context. All these stimuli characteristics are known to elicit better performances from children than abstract meaningless stimuli.

Secondly, strip-cartoon interpretation will involve relating in time two (or more) represented moments of an event, i.e. inferring from differences between pictures the transformation which has taken place. Since the child is familiar with the behavior of the represented objects, he is set to expect particular classes of transformations. His chances of interpreting correctly the transformations therefore appear greater than with abstract meaningless symbols of the type used by Gibson (1962) and Bryant (1969-1973).

Thirdly, the fact that represented objects are part of a context should help children to infer from these contextual cues the appropriate transformation.

However, in spite of the facilitating effect of these stimuli characteristics and the chosen experimental procedure, other factors remain as potential obstacles to a proper interpretation of transformations. Gibson (1955) found that errors in a discrimination task also depended on the number of stimulus differences by which an item differed from the standard. This evidence suggests that the child's interpretation of a transformation occurring between two represented moments of an event could very well be impaired if he did not perceive the difference between pictures. This particular factor will be investigated more thoroughly in the present study:

#### 1.4 Picture processing

This section will be devoted to children's picture processing strategies (descriptions of pictures and series of



pictures, scanning strategies...) However, the development of children's acquisitions in this domain will not be studied exhaustively. The account will deal with those aspects of the domain particularly pertinent to the current study. For instance, it is essential to know that children can extract information from 2D representations in much the same way they do with 3D information (Gibson 1969). In other words, children do not need to rebuild the 2D visual world the way they had to build the real world. Another pertinent piece of information can also be derived from Hochberg and Brooks' work (1962). They showed that a 2-year-old could recognise familiar objects in drawings and photographs. Guillaume (1953) also noticed the same ability with a 1-year-old child who could recognise the identity of an object with a drawing. Ryan and Schwartz (1956) and Fraisse and Elkind (1956) demonstrated children's ability to recognise line drawings and cartoon type drawings.

Concerning children's descriptions of pictures representing scenes, Amen (1941) found that from 2 to 7-years-old the child's description of pictures undergoes an evolution. From simple naming of elements, the child evolves to naming and describing actions (3-years-old), then he gives more active descriptions of pictures with added information on the meaning and purpose of the scenes (4-years-old). She noticed that the youngest children were easily attracted by one detail of the picture leaving out the rest of the information; others considered all information at the same level so that it became an enumeration of objects. Older children integrated the objects in the context trying to find out what was going on and why.

Hunton (1955) presented his subjects with familiar pictures

in the right-side-up orientation and in the upside-down orientation. Children who had been describing pictures in terms of relation tended to reduce their description to naming in the upside-down orientation; only older children conserved the same type of description.

Werner (1957) proposed the term "physiognomic perception" for the mode of cognition pertinent to the expressive or dynamic qualities of objects. He reports observations made by Gantschewa who noticed the preference of children for interpretation in terms of dynamic rather than static properties of objects: "A dog for the child is not an objective structure possessing objective shape and parts. The dog is something that bites or barks..." (p. 69). Wagner and Werner (1957b) carried out an experiment with children on the assumption that in the world of the child perception is not clearly differentiated into geometric-technical and physiognomic aspects but that directional dynamics (i.e. the vectorial quality expressed in some objects) in figures will be more potent determinants of the child's perception than that of an adult. The child's task was to adjust the speed of a series of discrete pictures so that they would move at the same speed as another series of pictures. Five pairs of pictures were presented; each pair comprised a static picture (e.g. a grazing horse) and a dynamic picture (e.g. a running horse). Younger children adjusted the dynamic picture series to a slower physical speed to equal its speed with the one of the static picture. Authors concluded that the effect of the directional dynamics on motion is greater in a young child and this decreases with age. At an early stage, an object cannot be divorced from the situation in which it occurs. Hence the child is dependent on the



perceived context.

Schnall (1968-1970) was interested in children's verbal description of pictures, more precisely in responses to "series of pictures going through progressive changes." He created two conditions in his experiment; one using concrete material and the other more abstract stimuli (geometrical figures). He found that concrete material was more readily described dynamically than the more abstract stimuli. In another study using familiarity and appropriateness as variables by opposition to the less meaningful stimuli and inappropriate changes, Schnall concluded that "spatio-temporal integration is affected by the familiarity of the object as well as the appropriateness of the depicted change".. This means that when a subject is presented with familiar stimuli undergoing an appropriate change (or expected type of transformation) he will more readily co-ordinate the two pictures in a dynamic type of description than he would if presented with unfamiliar shapes undergoing inappropriate changes. He argues that for grade 1 subjects (6-7-years-old) a particular object and its characteristic behavior appear to be an undifferentiated unit. Schnall found that shape and position types of changes were better integrated than colour changes. Since he only used one pair of stimuli to characterise each type of change, these results cannot be considered as very conclusive.

#### Picture seriation

Concerning children's interpretation of series of pictures, Piaget (1925a, 1925b) 50 years ago studied the child's conception of time using series of pictures. His observations led him to a number of conclusions which will be put forward here.

In one experiment where children were asked to interpret series of pictures (as a story), he concluded that up to 8 years of age 75% of children could not identify two pictures as representing the same story even if they admitted that the characters were the same. Children tended to juxtapose scenes. Piaget therefore divided types of behavior in two stages: the first one is a juxtaposition with no global vision of the series, the second stage is a genuine synthesis.

Piaget went on to say that the childish hypothesis is characterised by the fact that once it is formulated it is negated with difficulty.

In another experiment where children were asked to actually order series of four to six pictures, Piaget concluded once again that the child does not synthesise the set of pictures. He makes as many stories as there are pictures. Moreover, children tend to order pictures and then try to justify the order. The first order is usually the only plausible one. The order does not satisfy logic or causality, the child does not make hypotheses, his first idea is the only one.

Recalling the preoperational child's profile (second level) presented earlier, one will remember that one of the characteristics of this stage is a gradual decentration depending on progressive co-ordinations and that the "fonction constituante" is directed towards logic and causality. Piaget's (1925) conclusions on the child's ability to co-ordinate events in time do not exactly match with his later description of the preoperational child.

An inspection of the material which was presented in the two experiments reported above might suffice to justify the children's



poor performance in the story telling and ordering tasks. I therefore believe that using simpler tasks should be more profitable in assessing the child's potentialities to interpret sequences of pictured events.

Concerning the left-right order convention of seriations, Piaget also said that children did not follow the convention not only because they were not aware of it but because they could not understand it. A pre-experimentation with 5 to 7-year olds showed that children can be taught this convention and that they master it fairly rapidly (see section 1.1). Moreover, the experiment reported earlier (see 1.1) on the child's "spatial perception of a temporal series" showed that the child was conscious of the link between both the temporal and the spatial series. Hence he could understand the ordering system used by the experimenter to reproduce the temporal order of displacements.

#### The child's scanning strategies

A number of studies using measures of eye-movements have been carried out with children to analyse their strategies in obtaining information.

Pollack and Spence (1968) as well as Mackworth and Bruner (1970) found that young children do not always attend to "high rated information" and lack an adequate coverage of the display (their eye tracks average two-thirds the length of adult's tracks). Bruner agrees with Piaget's explanation that children show a lack of co-ordination between analysis and synthesis.

Piaget in Mecanismes perceptifs argues that exploration is an activity which develops with age and demands practice which no doubt itself requires direction. He goes on by suggesting that it

is probable that the progress of intelligence in general plays a role in this direction because to know what must be looked at in an object or configuration for it to be clearly perceived is in part a question of intelligence. (Neisser (1966) stresses the role of synthesis in the construction of a visual object; how and what information is picked up in the environment depends on the observer's intention and knowledge (or intelligence as Piaget puts it)). Piaget continues by saying that if the forms are simple and the structure strong, syncretism (global vision) dominates; if the forms are complex and the structures weak, minute details dominate. For Mussen, Conger and Kagan (1969), it is only when the younger child has difficulty identifying or labelling the whole and does not have any difficulty with the parts, that he will attend to the latter rather than the former. Piaget says that it is only at 7 years of age that the child manifests real strategies of exploration, i.e. systematic exploration (comparative movements increase with age).

Zaporozhets (1965) found that more time was spent focusing on the centre as opposed to contours of complex forms at 3 and 4 years of age while children of 5 to 6 years traced the outline of figures. Zaporozhets agrees with Piaget that exploration has to be directed and needs practice. He found that children could be trained to attend to certain visual elements of a complex form and construct real structures out of elements of different form and size.

Gibson (1969) Nodine and Steuerle (1971) Nodine and Simmons (1972) were interested in children's ability to differentiate letters. It was found that distinctive feature areas of letters were less attended to by 6 year olds (Gibson), that 6 year olds required more fixations, longer fixation durations and more cross



pair comparisons than older children to differentiate pairs of letters. Mussen, Conger and Kagan (1969) agree that the young child (4-years-old) requires a great deal of extra information in order to come to the same conclusion as that arrived at by older children with less information. In the same vein, Gollin (1960) noticed that the amount of completeness of representation required for recognition was greatest for the youngest children (3-4-5-years-old).

Vurpillot (1968) also noticed that children's judgements are based on only part of the potentially available information. Under 6 years of age children never took into account the whole of a stimulus. Vurpillot's theory predicts an increase with age of the extent in time and space of the range of perceptual activity.

Another study she conducted earlier with Brault (1956) demonstrated that children of 5 and 6 years of age paid relatively more attention to single identifying cues in viewing miniature objects whereas older children were more concerned with all the principal characteristics of the objects.

What emerges from these last studies is that the young child's exploration strategies appear to be syncretic, incomplete, not always directed towards "high rated information" and not very systematic. However, the child can be directed in his approach to information processing at a certain stage of development.

The remaining part of the introduction will state the questions with which this study is concerned as well as a few tentative predictions on the child's expected performance.

The first question to be answered in this study concerns children's ability to give a dynamic and generative interpretation of single static pictures. Evidence produced earlier (see Amen

et al.) demonstrated that young children not only describe pictures dynamically but prefer this type of description to the more static one.

Regarding the generative interpretation of pictures by young children, little information on the question as such, can allow us a positive answer. However, Cromer (see 1.2) claimed that young children could produce "statements of hypothetical nature" (i.e. could refer to possibilities), Piaget (see 1.1) characterised the preoperational child as evolving towards logic and causality and as being able to co-ordinate actions, and Werner (see 1.4) demonstrated children's interest in the "directional dynamics" of objects. All these factors characterising the child's mentality can be interpreted as signs of the child's ability to predict the outcome of a portrayed event (definition of the generative interpretation of a picture). It is therefore expected that children will be able to fulfill this part of what will be labelled in the current study the basic requirements for strip-cartoon interpretation. (This question will be tested in the next two chapters of this study).

The next point to be elucidated is children's ability to co-ordinate two pictures representing two moments of an event and to interpret the different types of change (classes of transformations) taking place between the two represented moments. Schnall (see 1.4) has already pointed out that a child (age 7) can co-ordinate two pictures representing familiar stimuli undergoing an appropriate change. However, since his experiments were carried out with subjects older than the ones to be tested in the present investigation, one cannot assume on those grounds alone that 5 to 7-year-olds will also be able to complete such a task.



The work reported earlier (see 1.3) on children's ability to interpret orientation and perspective transformations (which are considered to be the most difficult classes of transformations for young children) raised controversial issues. It was then argued that depending on the material and procedures used in assessing children's ability to cope with various classes of transformations one could expect a continuum of responses. In the present investigation, the method chosen to assess this skill (strip-cartoon interpretation) is expected to provide the child with greater opportunities of expressing his potentialities.

However, predicting subjects' behavior with various classes of transformations cannot be done without taking into account the child's cognitive level and what is already known on his information processing strategies.

The main part of this introduction has already revealed some of the preoperational child's assets and deficits in various problem-solving situations. However it is felt at the present moment that this information is insufficient for us to make definite predictions on the child's ability to interpret strip-cartoons even though some tentative predictions have already been proposed.

The present study will provide a new way of studying the child's seriation ability. Indeed up to now, this ability has been measured with spatial seriations like the rod seriation task. Its main concern will be to answer questions such as: How do children evolve in picture seriation tasks? how does this evolution compare with the evolution observed with the classical seriation task? What strategies are used to accomplish these two types of seriation tasks? What does the picture seriation task measure compared to the rod seriation task? What are the advantages and the limitations of the two seriation methods?...

## First part

### Basic requirements for picture ordering tasks

#### Introduction:

The first part of this study involves an assessment of a number of basic requirements for a picture ordering task. Some of the experiments which will be reported here are pilot studies which have been performed on a group of children different from the one used in the proper experiments. The purpose of these pilot studies was manifold. Firstly, their aim was to test children's spontaneous reactions to pictures and their types of descriptions. Secondly, different types of instructions were tried out to check children's comprehension; and thirdly, these pilot studies were used to delimit the age range of subjects who would be tested in the study proper. Some of these pilot studies will be reported here along with proper experiments.

The first part of the study is divided into two chapters. The first, (chapter 2), comprises three experiments and the second, (chapter 3), involves one experiment.

The first two experiments reported in chapter 2 investigate children's ability to use motion cues. The experiment reported in section 2.1 tests children's ability to give dynamic descriptions of static pictures and the one reported in section 2.2 involves choosing from three pictures the one expressing an active relation between an actor and an object. Both of these experiments share the same experimental context and can be considered as two modes of responding to the same question, i.e. the ability of children to interpret dynamically static pictures. The third experiment, reported



in section 2.3, assesses children's ability to give a "generative interpretation of static pictures". Now, if the child is expected to perform picture ordering tasks, he must be able "to predict the outcome of a portrayed action" (generative interpretation). As well as assessing children's power of prediction, or the ability to infer a consequence from a portrayed action, this experiment also assesses children's ability to make hypotheses and their ability to construct moments occurring in-between the pictured moment and the predicted outcome. All these cognitive abilities are basic prerequisites to the more complex task of relating events in time using series of pictures.

Chapter 3, which completes the first part of the investigation, reports an experiment assessing children's ability to recognise differences between pictures. Indeed, in a picture ordering task it is from the perception of differences between frames that the child will deduce the nature of the transformation (or action which has taken place between the two represented moments of an event). It is therefore essential for the child to see differences between frames and in a further step, to use these differences between frames as cues pointing out the nature of the transformation and the probable order of the pictured events.

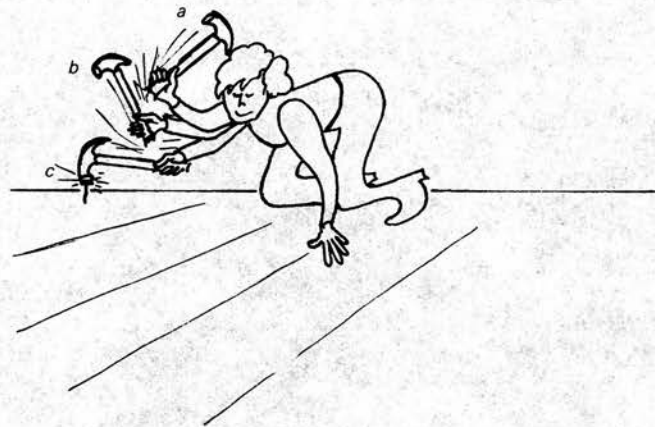
## CHAPTER 2

Dynamic and generative interpretation of static pictures2.1 Dynamic description of a single pictureIntroduction:

Deducing motion from a static picture appears to be a fairly direct type of interpretation for adults; it at least seems that no conscious effort of construction is undertaken. However, it often seems very difficult to a layman to give the impression of motion in drawing a static picture (a fact which immediately suggests the existence of a fairly complex type of processing). One rule which seems to work in the static representation of motion is to draw the object in a state of "desequilibrium", i.e. in a state in which no object or person would normally be maintained static. If this drawing trick is effective to produce an impression of motion it might be that desequilibrium is the cue which one can use to infer motion from a static picture. Moreover, to perceive this desequilibrium one must have some knowledge of the behavior of the represented object, otherwise one would find it difficult to recognise that the object is in motion.

A dynamic interpretation of a static picture also involves referring to the immediate-past and immediate-future states of the portrayed action. This process should be clarified by the following example (see Fig. 1).





To interpret picture 1 dynamically involves firstly an identification of the objects (man, hammer, nail, floor...) and a knowledge of their behavior (a man can hit with a hammer, a hammer is used to hit nails, nails go into boards...) In order to say that the man is hammering, one has to reconstruct a series of moments representing the continuous process of hammering (picture 2). Some of these moments happened before the one represented in picture 1 and some of them after. The observer decomposes the event and infers that the man's arm was successively extended towards the back (a), then towards the front (b), and then touching the nail through the mediation of the hammer (c). (This process of decomposition is not necessarily intentional it can be quite automatic with experienced observers.)

Young children can identify pictures of familiar objects. Therefore, they can perceive in 2D features which they have learned to perceive in 3D (Hochberg and Brooks , 1962). They also make a difference between a static representation of an object and a

dynamic representation of the same object (Wapner and Werner, 1957) so they must be able to pick up "motion cues" (e.g. the disequilibrium already mentioned). According to these findings and what was said about the dynamic interpretation of pictures, there are no evident reasons to believe that children are not able to interpret pictures dynamically. In order to confirm such a prediction, s children were presented with two experiments, the first one serving as an introduction to the second (these two experiments were part of a set of pilot studies).

#### Material:

Subjects were presented with a series of 19 single pictures taken from a reading book. These pictures represented action verbs and were normally used to teach the child the spelling of the verbs. In the context of this study, these pictures were used because they represented simple actions which the child would be asked to identify. Pictures represented actions such as running, dancing, walking, horseback-riding, hammering, crawling, flying, cycling, eating, pushing, pulling...etc.

#### Subjects:

The mean age of the 11 subjects tested was 5 years and 4 months (5;4); (the youngest was 4;11 years old and the oldest was 5;10 years old). These children attended Primary 1 classes in an Edinburgh school. They came from lower to middle class backgrounds and were considered by their teachers as "normal children".

#### Procedure:

The child was presented with a series of 19 pictures in



succession and asked; "What do you see?" If the child did not give an active description of the picture (e.g. a boy and a bicycle instead of a boy riding a bicycle), he was asked, "What is he doing?"

This test was followed by another experiment which will be described in section 2.2. The total session usually lasted approximately 15 minutes and most children appeared to be very much at ease during the whole session.

### Results:

Most of the children who, in the first few presentations, had to be asked, "What is he doing?" in order to give a dynamic interpretation, rapidly switched to a spontaneous dynamic description for the rest of the presentations. In fact, 69% of spontaneous answers were of the dynamic type and 31% of answers were of the static type. However, all children were able to give an active description of pictures even though some children had to be questioned on the represented activity. Some subjects behaved as if they were waiting for the second question ("What is he doing?") to give an active description of pictures even though they had no difficulty in providing dynamic interpretations.

### Conclusion:

Children interpret dynamically static pictures, if not always spontaneously, surely after being questioned more directly on the nature of the action. This experiment confirmed observations made by Amen (1941) and Hunton (1955) on children's dynamic descriptions of pictures.

## 2.2 Selection of the picture representing an active relation between two objects

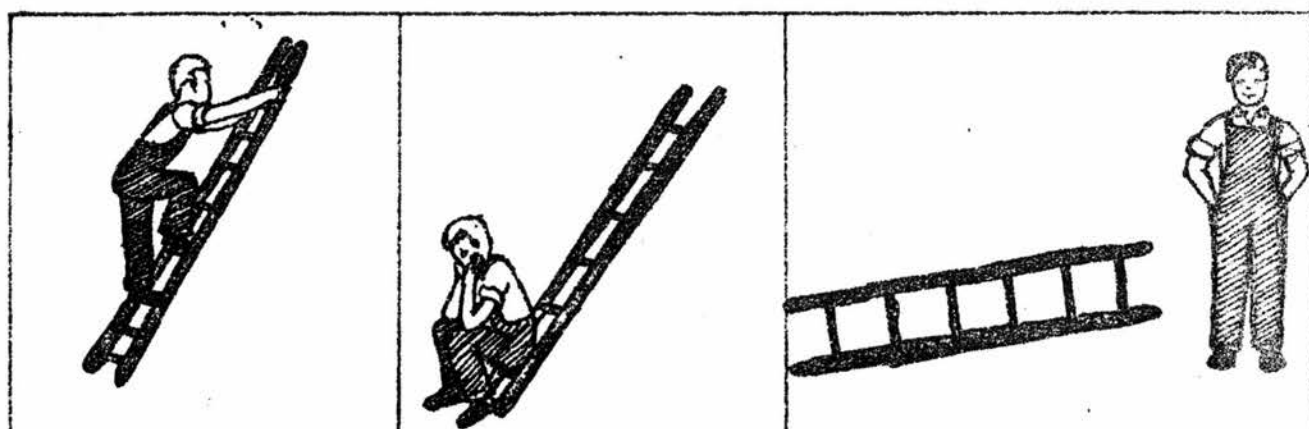
### Procedure and Material:

After being asked to give a dynamic interpretation of single static pictures children were then given the problem of selecting from four sets of three pictures the one picture in each set representing an "active relation" between an actor and an object. The purpose of this experiment was to see if children were sensitive to motion cues within a relation between elements. The types of relation represented in the sets of pictures have been labelled in the following way: active relation (the actor is moving or using the object); passive relation (the actor is in physical contact with the object but he is not moving it); no physical relation (no physical contact between the actor and the object). The active relations are represented by: a man climbing a ladder, a girl pushing a pram, a boy pulling a toy train, a boy bouncing a ball. The passive relations are represented by: a man sitting on the first bar of a ladder, a girl touching a pram, a boy holding a toy train and a boy sitting on a chair holding a ball.

The child is asked to select the picture representing what was labelled as the active relation.

"I will show you three pictures. In one of these pictures somebody is doing something. I would like you to tell me which one of the three pictures shows somebody doing something."





### Results:

Children's answers were classified according to the picture they chose as representing the active relation. If they chose the picture labelled active relation, their answer was classified in the active relation category. If they chose the picture labelled passive relation their choice was classified in the passive relation category. Table 2.2.1. displays the 11 subjects' choices from the four sets of pictures according to the three categories of relation.

Table 2.2.1 Distribution of subjects' choices according to the three categories of relation. (N=11)

Active relation	Passive relation	No relation
37/44 (84%)	7/44 15%	0

Eighty-four per cent of answers (37/44) correspond to the anticipated choice, i.e. children selected the picture labelled "active" relation. One child chose the picture labelled passive relation three times out of four, two other subjects chose the passive relation once and another subject twice out of four possible choices.

Table 2.2.2 displays subject's choices of the active relation picture for each one of the four sets.

Table 2.2.2 Active relation choices to the 4 sets of pictures.

Pram	Train	Ball	Ladder
8/11	9/11	9/11	11/11



### Discussion:

As indicated by the results, dynamism is interpreted more often in a situation, where an "active relation" is expressed between an actor and an object. However, some children also interpret as dynamic, the more passive type of relation. For these children a simple contact between an actor and an object is sufficient for them to infer that an action is taking place. This choice is legitimate if one considers holding, sitting, touching as actions, but in comparison to climbing, bouncing, pushing and pulling these actions imply much less physical activity. It therefore seems that, depending on the context in which the task is embedded and on the way one understands instructions, action can be seen in pictures representing passive relations as well as active relations. However, the majority of subjects chose pictures in which more activity between the actor and object was taking place, so they can discriminate within different categories of relations the relation expressing motion in its more dynamic form.

### 2.3 Generative interpretation of pictures

#### Introduction:

A generative interpretation of a picture not only involved the dynamic construction described at the beginning of section 2.1, but calls for a certain "detachment" (the capacity to take some distance from the represented event) allowing for an expansion or prolongation in time of the represented scene. Using the pictures' perceptual constraints (spatial organisation of elements), one is asked to predict the consequence of the represented action; the looser these constraints the wider the scope for prediction.

Furthermore, the scope of prediction can be extended in time, allowing for the production of more remote predictions rather than immediate ones. Such an extended scope calls for a greater power of prediction coupled with a greater power of decentration (or detachment).

As was said before, the ability to interpret generatively static pictures is a ~~necessary~~ prerequisite to picture ordering tasks, the latter being an extension of the former but involving many more constraints.

The purpose of the following experiment is to evaluate children's ability to provide generative interpretations to static pictures and to see how remote in time their expansion of the portrayed action can extend.

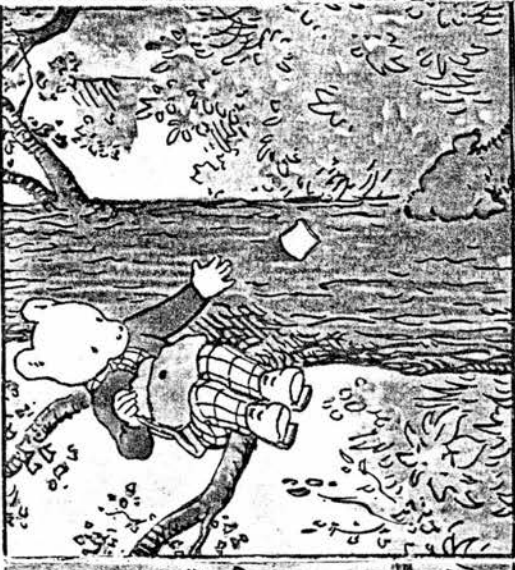
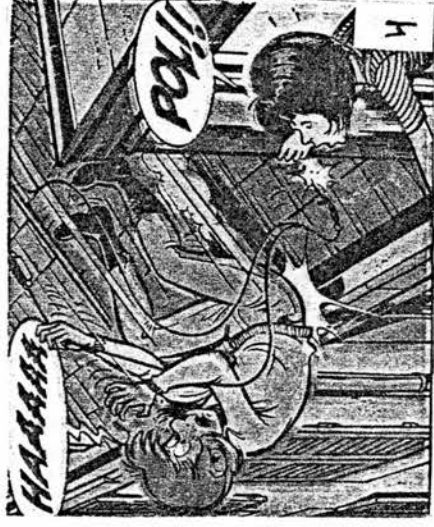
#### Material:

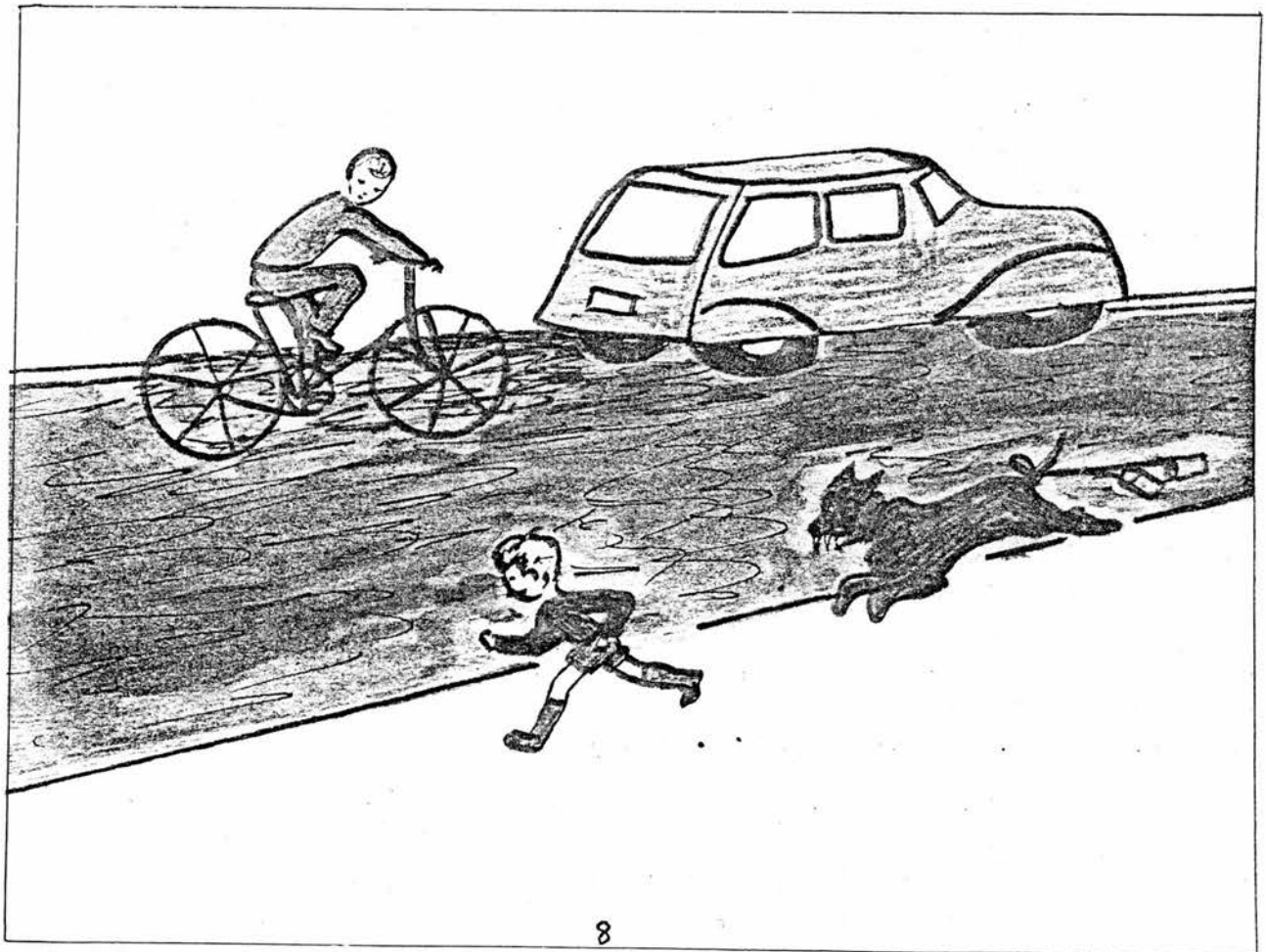
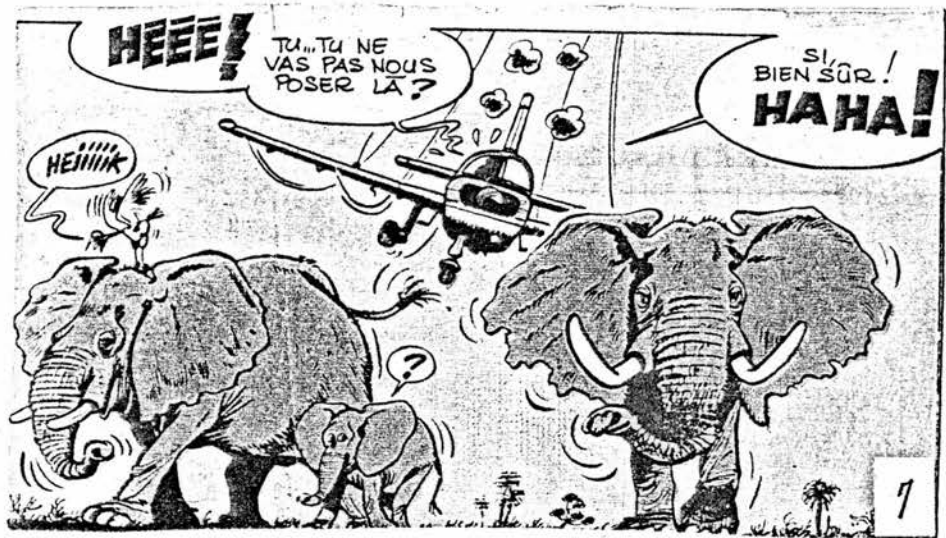
The ability to provide generative interpretations was assessed through the presentation of a series of 12 pictures (some of them are presented on the following pages) in graphic expression: coloured line drawings and cartoon type pictures. These cartoon type pictures were taken either from the Daily News Annuals 1972-73 (Rupert the Bear) or from a Belgian strip-cartoon magazine.

#### Subjects:

The pictures were presented to 20 subjects of an average age of 5;7 (the youngest being 4;9 and the oldest being 7;1). The sample consisted of nine girls and eleven boys attending Primary 1 classes in two Edinburgh schools. Subjects came from lower to middle class areas and teachers considered these subjects as normal children with some of them being "smarter" than others.









Procedure:

Children were individually tested with pictures presented in random order. All descriptions were tape-recorded.

Instructions:

Subjects were instructed as follows:

"I will show you some pictures; on these pictures somebody is doing something. I would like you to tell me what they are doing and what you think is going to happen if they go on doing what they were doing."

The most frequent comment voiced during the experiment was to ask the child, "What happened?" after he had described the picture. Some other comments were made on occasion to either encourage the child to verbalise further or to direct his attention on certain aspects of pictures. These comments will be referred to in the next section of the report.

Results:

In a first analysis, subjects' descriptions were divided in three main categories of responses according to the first response given. Subjects whose first answer was a generative interpretation of pictures were classified in the first category (spontaneous generative S.G.) Subjects who gave a dynamic description in the first instance but who then responded adequately to the question, "What happened?" fell into the second category (spontaneous dynamic and secondary generative S.D.S.G.). The spontaneous naming and secondary generative description (S.N.S.G.) category included subjects who in the first instance named objects before following instructions. Table 2.3.1 reports the percentage of descriptions in each category as well as three sub-categories: spontaneous dynamic description,

S.D. (no generative description is given), spontaneous naming description, S.N. (no generative description is given) and the no response category, N.R.

Table 2.3.1 Classification of subjects' descriptions according to three main categories and three sub-categories. (N=20, N of responses=240)

S.G.	S.D.S.G.	S.N.S.G.	S.D.	S.N.	N.R.
46%	48%	3%	1.2%	1.2%	.4%
Total number of G (generative) response: 97%					

In a second analysis the data were redivided in two categories, this time according to the dimension of "distance" in time of the predictions. These two categories were labelled "immediate outcome (Immediate 0)" and "remote outcomes (Remote 0)". Table 2.3.2 displays the distribution of descriptions according to these two categories.

Table 2.3.2 Distribution of subjects' descriptions according to the distance in time of predictions.

Immediate 0	Remote 0
79%	20%

These two types of outcome are exemplified by predictions made to picture 3. This picture represents a dwarf offering a glass of juice and a cake to Rupert. The immediate type of outcome predicted is that Rupert will take the food and eat or drink it. The more remote type of outcome predicted is that Rupert will take the "poisonous drink" and die. Many of children's remote predictions involve death as the outcome of some fatal accident or encounter.



Table 2.3.3 List of the pictures (their numerical labels) with the most usual outcomes predicted.

Picture	Predicted outcome
1	Toys will come out of the box, break (N=17), they will go away and may be caught (N=3)
2	The dog will eat the sandwich (N=20)
3	Rupert will drink the juice (N=17)
4	The man will hurt himself
5	The man will fall and hurt himself (N=11), get run over by another car (N=9)
6	The man will pick up an object
7	The plane will hit the elephants and crash
8	The cyclist will run into the car
9	The plane will land
10	The boy is going to eat the chicken, he'll be sick, fat, finished
11	The ball will go into the net
12	The lady will finish hanging her clothes

In a further analysis, subject's answers were scrutinised in order to find material which might throw some light on other aspects of picture processing or on aspects which elicited some interest. In the following paragraphs attention will be called to some of these findings. (Each paragraph is headed by the number(s) of the picture(s) concerned.)

#### Picture 2

This picture represents Rupert dropping or giving a biscuit (or sandwich) to a dog. Only the back of the dog's head can be seen



in the bottom right hand corner of the picture. Nevertheless, subjects were able to recognise from this partial information the fact that it is a dog, which leads us to suggest that, the context permitting, children are able to deal with problems of occlusion and incomplete forms.

### Picture 3 and 6

These two pictures expressed a certain "unusualness" for some children (four cases for picture 3 and four cases for picture 6). This "bizarness" appears to be created in one case (picture 3) by the unfamiliar aspect of the character and in the other case by the ambiguity or uncertainty of the context. These observations suggest that unfamiliarity and ambiguity, when perceived, can affect children's predictions. What is interesting is that adults do not usually perceive these pictures as particularly bizarre so it would appear that children's threshold of "uncertainty" is lower than adults'. For this reason, it might become quite difficult to predict the degree of ambiguity of pictures since adults and children do not share the same criteria to evaluate ambiguity.

### Picture 8

This picture represents a combination of three simultaneous actions: a cyclist is riding behind a parked car (1), looking across the road (2), at a dog chasing another boy (3). The most plausible outcome to be predicted from these actions is that the cyclist will run into the car because he is not looking where he is going. This type of prediction which involves a sophisticated process of inference (since it implies the combination of many different cues), was given by nine subjects. Seven other subjects



who were questioned about the direction of the cyclist's gaze or the position of the bicycle relative to the car predicted the same outcome. (Some of those subjects had already made another plausible prediction. The reason why they were questioned was to find out if they could also reach the same conclusion if their attention was directed towards the appropriate cues.) The nine children who made the above prediction had an average age of 6;1, the mean age of the sample being 5;7.

### Picture 12

This picture represents a lady hanging her clothes and the typical prediction is that there will be more clothes on the line when the lady has finished hanging up her washing. Two subjects said that the wind would "start" blowing when the woman finished hanging the wash. This type of response suggests the existence of an animistic residue in some children since they respond as if they believed that the wind was waiting for a signal to start blowing.

### Conclusion:

The main issue under consideration was the ability of children to give generative interpretations of pictures. Results are sufficiently eloquent to assure us of the child's competence in making predictions on the outcome of a pictured action. However, these predictions tend to be restricted to immediate outcomes rather than more remote outcomes. This state of affairs does not, however, imply that children are not able to predict future events since some of them showed that they could and since children were not explicitly instructed to make such future predictions. Nevertheless, it is still believed that to be able to extend one's predictions in

the future is a sign of an ability to decentre in time and a possible sign of a potentiality to broaden one's scope of predictions (i.e. a variety of predictions can be made).

It is obvious from children's answers that they relate elements of pictures, otherwise they would not be able to propose the consequence of these relations. Over and above being able to make these "spatial relations", they seem to be able to make "time relations" as well, since they can predict an event occurring after a certain lapse of time (from the pictured moment). This implies the construction of the intermediate moments occurring in-between the represented event and the predicted consequence of the action.

Such a construction is essential in picture ordering tasks since subjects will have to co-ordinate moments in time, some of which will be represented in pictures and some of which will have to be totally inferred. The task of co-ordinating represented moments in time necessitates a thorough analysis of each individual picture of a series, and the skill which the child has demonstrated in constructing intermediate moments with a single picture is not enough to guarantee that he will be able to co-ordinate adequately all the information provided in series of pictures, especially if there is a lot of information to process.

The importance of the process of construction in picture ordering tasks has just been emphasised and it was suggested that one has to conduct a thorough analysis of pictures in order to co-ordinate events in time. This analysis partly involves the perception of differences and similarities between frames and it is from these differences and similarities that one can deduce transformations and perceive continuity. In the next experiment this



aspect of the analytical process will be investigated, i.e. the child's ability to see differences and similarities between pictures.

## CHAPTER 3

Children's ability to recognise differences between  
frames and interpret them as a transformationIntroduction:

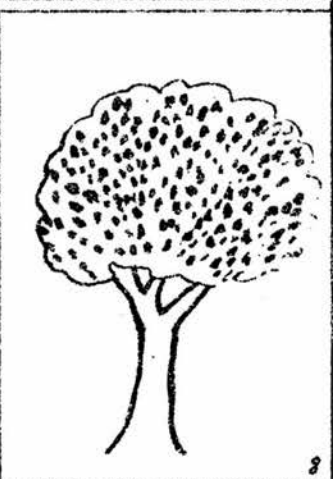
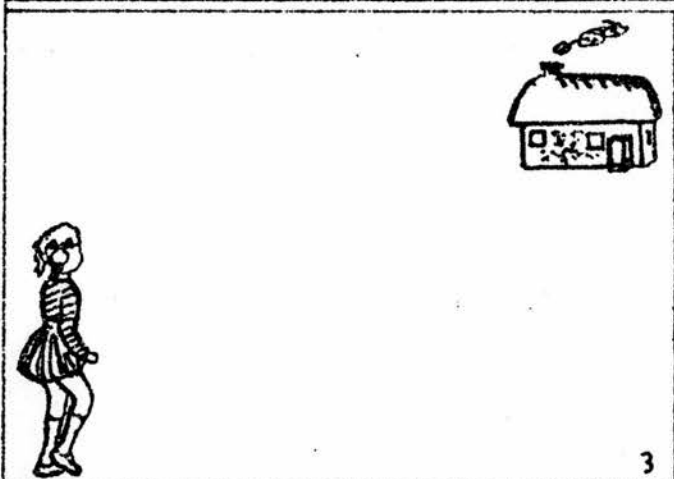
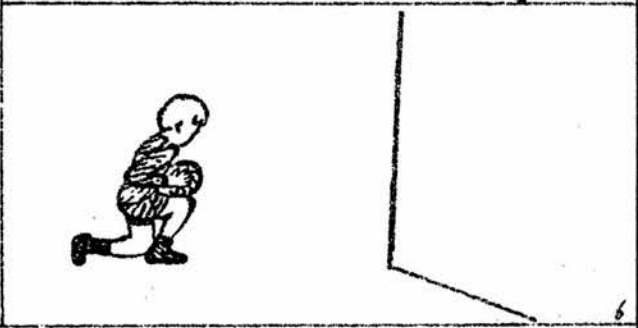
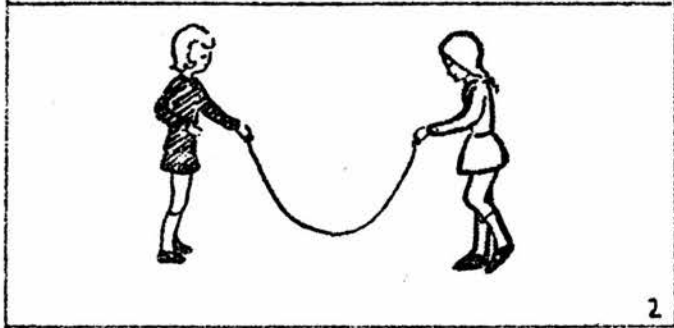
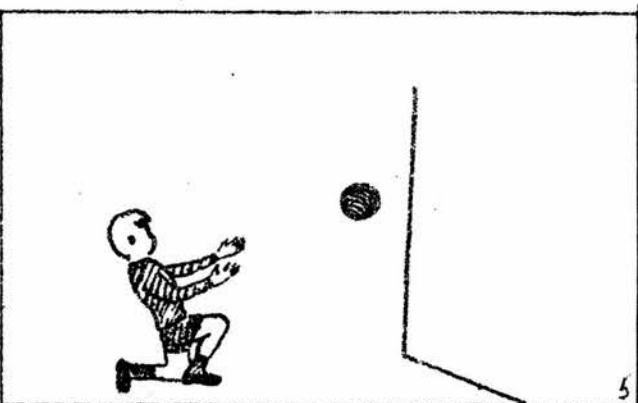
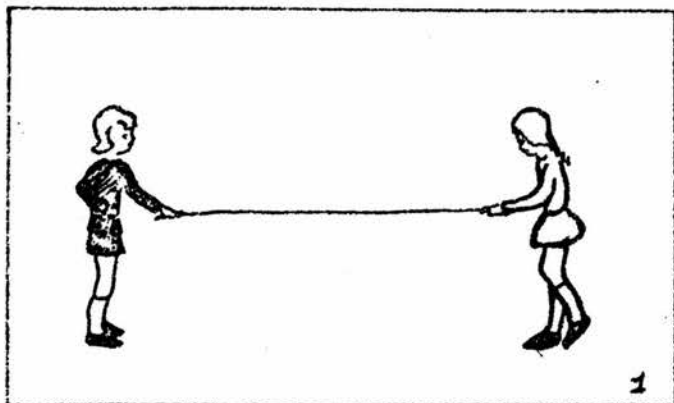
The importance of analysis of sets of pictures in terms of similarities and differences has already been stressed in the introduction of the first part of this study as well as in the conclusion of section 2.3. Indeed such an analysis is the means by which the context is extracted from a series of pictures. At the same time it provides the new structure for the reconstruction of each represented moment into a coherent sequence of events.

The purpose of the experiment is to investigate the first step of this complex process of analysis, i.e. the ability to perceive differences between two frames. Furthermore, it would be interesting to find out if children spontaneously interpret the difference between two frames in terms of transformation. This interpretation implies relating the two pictures into a common context where each frame is seen as one moment of an event and where each one of these moments occupies a particular position in time relative to one another.

Material:

This investigation was conducted with the use of five sets of two pictures (coloured line-drawings) representing changes of shape, size, colour, position and distance. Some of the sets represent transformations of animate objects and others of inanimate objects (pictures are presented on the following page). An effort to portray different classes of transformations was made in order to see if some of them were easier to perceive than others by children.





However, since each class of transformation is only represented by one set of pictures, it will be necessary to restrict the extension of any possible prediction.

### Subjects:

This experiment was conducted with 19 subjects; their average age is 5;7 (subjects' ages varied from 4;9 to 7;1). These subjects have already been tested with experiments presented in section 2.3 (generative interpretation of pictures).

### Procedure:

Subjects were tested individually and presented with the five sets of pictures. These sets were presented in the numerical order presented above. The reason why set 9-10 was presented at the end of the session was because subjects would be questioned on the nature of the transformation portrayed in this set, representing a candle melting, if they had not done it spontaneously. Since no questioning was done with the other sets of pictures, this precaution was taken to avoid influencing subjects' type of response. Each set of pictures was displayed on a table with the odd numbers on the left-hand side of pair numbers (e.g. picture no. 1 was placed on the left of picture no. 2, picture no. 3 on the left of picture no. 4 and so on...).

Depending on children's response to set 7-8, this set was presented again after set 9-10 and children were asked if trees actually changed colour and how they would interpret set 7-8 if they accepted that trees did change colour. This little test was done to see how familiar children of this age group were with manifestations of seasonal changes. This question was motivated by



the general interest this study holds for children's understanding of time concepts. Apart from these interventions with pictures 7-8 and 9-10 no comments were made which would have suggested answers in terms of transformation rather than simple differences.

#### Instructions:

"I will show you two pictures and I would like you to tell me what is different between these two pictures or what is not the same between the two pictures." <sup>2</sup>

#### Results:

When children were presented with a set of pictures they either described what was on the picture in a static form (e.g. set 5-6 would be described as representing a boy and a ball) or described dynamically the content of each picture (e.g. set 5-6 would be described as such, "He is throwing the ball, he is catching the ball"). There were more dynamic descriptions (70.5%) than static descriptions (29.5%).

As far as children's response to instructions about the difference between frames is concerned, Table 3 divides results into three categories of responses: category 1 - static differences (e.g. it is long, it is short), category 2 - transformation a (e.g. she is far away, she is getting nearer), category 3 - transformation b which involves transformation type answers given after questioning for sets 7-8 and 9-10.

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<sup>2</sup>Care was taken to utilise both expressions: "different" and "not the same" in instructions in the eventuality of a misunderstanding by subjects of the expression "different". Donaldson and Wales (1970) have shown how confusing "same" and "different" can be for young children.

Table 3; Distribution of responses obtained for each set of pictures according to three categories of differences between frames. (N=19)

Sets	Static difference	Transformation <u>a</u>	Transformation <u>b</u>
1-2	12	7	
3-4	5	12	
5-6	8	11	
7-8	16	3	4
9-10	13	5	8
total : 54(57%)		38(40%)	12
Total percentage of perceived differences: 97%			
transformation <u>a</u> and <u>b</u> : 52.5%			

Ninety-seven per cent of answers showed that children perceived differences between sets of pictures (there are three cases of undifferentiation). Forty per cent of answers were offered by children who related the two pictures by interpreting the difference in terms of a transformation (17 subjects out of 19 produced at least one transformation type answer). To exemplify "transformational answers" (this will be the label used to refer to transformation type answers), here are some of the responses given by subjects to set 3-4:

1. "She is going home and now she is nearly home",
2. "She is running home, she is nearer now"
3. "She walked a bit further"

Differentiating pictures 5-6 children would say:

1. "He threw it and it's coming back"
2. "He threw it, he's ready to throw it again"
3. "He threw it, he caught it and he's going to throw it again" (this child is prolonging the action of picture 6 to a more remote event).



Except for some answers to set 7-8, the transformation was described using the picture presented on the left-hand side of the table as the first moment of the event.

The first three sets of pictures (1-2,3-4,5-6) representing people in action invite more dynamic interpretations of differences (transformation a) than the two sets representing inanimate objects (see Table 3). Five subjects spontaneously gave a transformational answer to pictures 9-10 and when questioned eight more subjects responded with a transformational answer. Questions were as follows: "What happens when you light a candle?" When the child had answered that "candles melt, go down or become wee-er", he was asked, "What do you think happened in these two pictures?" (if he had not already made the relation on his own). However, some children (six) still could not figure out this type of transformation even though they all have seen candles burning (I have witnessed that they have all observed candles burning on a birthday cake in their classroom).

As far as set 7-8 is concerned, the concept of seasons appears to be very poor for these children and even if most of them think that there are at least three seasons (spring, summer and winter; no-one mentioned autumn) or at least two seasons, some of them do not associate the change of colour of leaves with the change of season (e.g. "when trees are asleep they are green"). If they do associate the two, the association is not appropriate (e.g. "leaves are green in winter" or "leaves fall in spring").

Concerning classes of transformations (shape, colour, distance, position, size) portrayed in the five sets of pictures, sets portraying changes of distance and position were more spontaneously described in terms of transformation than changes of shape, size

and colour.

### Discussion:

To start with, let us discuss transformational answers relative to classes of transformations portrayed in the sets of pictures. It was just said that distance and position invited more transformational answers. However, if children had been explicitly asked to relate pictures and interpret them in terms of transformation, the actual predominance of certain classes of transformations over others might have been non-existent. For this reason it becomes very risky to make any definite predictions as to the relative difficulty or facility inherent to various classes of transformations. The simple fact that set 9-10 produced eight more transformational answers when children were questioned further leads us to believe that the same increase (if not a greater one) would have occurred for sets 1-2,3-4,5-6. However, taking into account results obtained with set 7-8, the scope of this prediction has to be reduced. It seems obvious that children's lack of experience with certain situations (or stimuli) will always be a drawback for any generalised predictions. Indeed the nature of the presented stimuli seems to be an important factor to consider when assessing children's ability to deal with different classes of transformations. Schnall (1968-1970) found that sets of pictures representing concrete familiar objects undergoing appropriate changes were better co-ordinated than abstract unfamiliar ones undergoing inappropriate changes (see section 1.4).

To come back to the main point of this investigation which was to find out if children could perceive differences between two frames, results clearly demonstrate this ability (97% of subjects'



responses expressed differences). Lloyd found that as the child gets closer to five years old, he becomes able to pick out "features which carry most information" in a discrimination task (Lloyd, 1974, p.118). Subjects undergoing the discrimination task were very quick in picking up differences between pictures even though pictures did not vary a great deal.

Cases of non differentiation (three) open up an area of speculation at this point of the study. For the time being let us say that the "size of the difference" between two frames might be an important variable in the child's ability to order series of pictures in proper sequences. Indeed, if pictures are not differentiated the most probable reason for this lack of discernment is that for the observer the difference between the two frames is not "big" enough, or not "salient" enough (in as much as the stimuli are familiar and meaningful).<sup>3</sup>

In the context of picture ordering tasks the problem of the "size" of the difference between frames has another side to it. Over and above the difficulty in differentiating pictures, the child might also have difficulty in seeing continuity throughout a series of pictures which are "too different". Indeed, when the child is asked to co-ordinate moments of an event in their order of occurrence, he must be able to find a common context to the series of pictures. The "greater" the difference between each frame the more difficult it becomes to find out the actual order of occurrence of moments. At the limit almost any order could be legitimate and logically justifiable.

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<sup>3</sup>See appendix.2.

The question of the "size" of the difference between frames leads to the question of children's ability to perceive similarities between frames. With the sample of stimuli presented in this experiment, 17 out of 19 subjects were able to interpret at least once the difference between the two frames as a transformation. This type of response indicates that subjects related both frames to a common context which implies that they identified elements of both frames as the "same".

This ability is essential in picture ordering tasks since the purpose of the whole exercise is to rebuild the continuity of an interrupted sequence. In order to perceive continuity one has to pick up the invariants through change.

If children are able to interpret differences between frames in terms of transformation this already hints at their capacity to make inferences. Indeed, in order to give a transformational interpretation of two pictures, one has to compare the information in one picture with the information in the second picture and "deduce" that a certain action must have occurred between the first represented moment and the next one to justify the state of the second moment relative to the first one. Since the action cannot be directly perceived, it has to be inferred.

It is interesting to note that subjects always used the first presented picture (i.e. the one presented on the left-hand side of the table) as starting point to describe a transformation. This order was the most plausible sequence but it would be interesting to see if subjects would have reacted differently if the picture representing the second moment had been presented first. The next chapter will attempt to answer this question as well as the main



question stated at the beginning of this study, i.e. the ability of children to order series of pictures in coherent sequences.

With this chapter, the section of the study concerned with evaluating subjects' ability to satisfy certain basic requirements of picture seriation tasks is now closed. It provides us with the possibility of proposing a procedure or a possible set of rules to order two pictures.

The following procedure could be used to seriate two pictures:

1. Recognize the pictured elements and their topological relations;
2. Interpret dynamically the interactions represented in each frame;
3. Identify the similarities and the differences between each frame and interpret them in terms of transformations;
4. Relate temporally each moment of the event using knowledge or experience of the represented event.

## Part 2

### CHAPTER 4

#### The first picture effect: a rather sophisticated type of preoperational rigidity

The second part of this study is devoted to the assessment of children's ability to perform picture ordering tasks. Experiments reported in the previous chapters revealed that children possessed a "potential" for picture ordering tasks namely the ability to give dynamic and generative interpretations of pictures as well as the ability to differentiate two frames and perceive the similarities between them. It was also argued from findings in chapter 3 that children might be able to interpret two pictures as two moments of the same event; however, since children were not explicitly instructed to give transformational answers, results could not be conclusive.

The purpose of the next experiment is to shed some light on this matter. It should provide us with some information relating to the question which was raised at the end of chapter 3, namely if children are influenced by the order of presentation of pictures. Indeed, since subjects tended to choose the first presented picture as the first moment of the event it might be that they were really convinced that picture 1 could only represent moment 1 of the transformation or it might be that they were influenced by the order of presentation of frames.

#### Method:

Before children were presented with the experiment proper, they were given a pre-test; one of the aims of this pre-test was to help children understand that the first presented picture did not



necessarily represent the first moment of a sequence.

In order to check if the order of presentation of pictures influenced subjects' choice of the sequence, a two-picture situation was set up. In this two-picture situation (picture 1, picture 2) half the presentations were of the type 1-2 and half the presentations of the type 2-1, i.e. pictures were presented one at a time and half the time picture 1 would be presented first and half of the time picture 2 would be presented first. Sets of pictures were selected to be of varying degrees of ambiguity and some of them were very ambiguous ("maximum ambiguity" meaning that the order of the pictures in the set is as plausible in one way as in the other.) With the most ambiguous sets, one would normally expect subjects to choose picture 2 as representing moment 1 as often as they would choose picture 1 to represent the same moment 1. However, if children are influenced by the order of presentation of pictures, they would probably use picture 1 as starting point of the sequence when presented with it first and use picture 2 when presented with it first. Using totally ambiguous pictures would indeed be the best way to bring out the effect of the order of presentation of pictures or "the first picture effect". The reason why sets of varying degrees of ambiguity were presented was to see the extent of the dominance of the first picture effect on subjects' choices especially in cases where the sequence of events is "strongly oriented" in one direction.

In the above paragraph, reference was made to the "varying degrees of ambiguity of sequences of pictures" and to the "plausibility of sequences of pictures". Adults were tested in order to establish the plausibility of sequences of pictures to be used in this test and they were also asked to classify these sequences of

pictures on a continuum of ambiguity. Since the testing procedure was the same as the one used with children it will be possible to compare both groups and see if the "first picture effect" is typical of young children's behavior alone.

#### Material:

Seventeen sets of two pictures were used (i.e. a total of 34 pictures, presented on the following pages). Seven of these sets were coloured line-drawings. The ten other sets were pictures taken from two Rupert Daily Express Annuals (1972-1973 publications).

These sets of pictures representing sequences of events, were distributed along a continuum of ambiguity by ten judges. They classified all the sets of pictures along a scale of ambiguity (high, medium or low level of ambiguity).

#### Pre-test material:

Two pictures representing the experimenter holding a book on her head and the experimenter putting a book on the table were used in the pre-test.

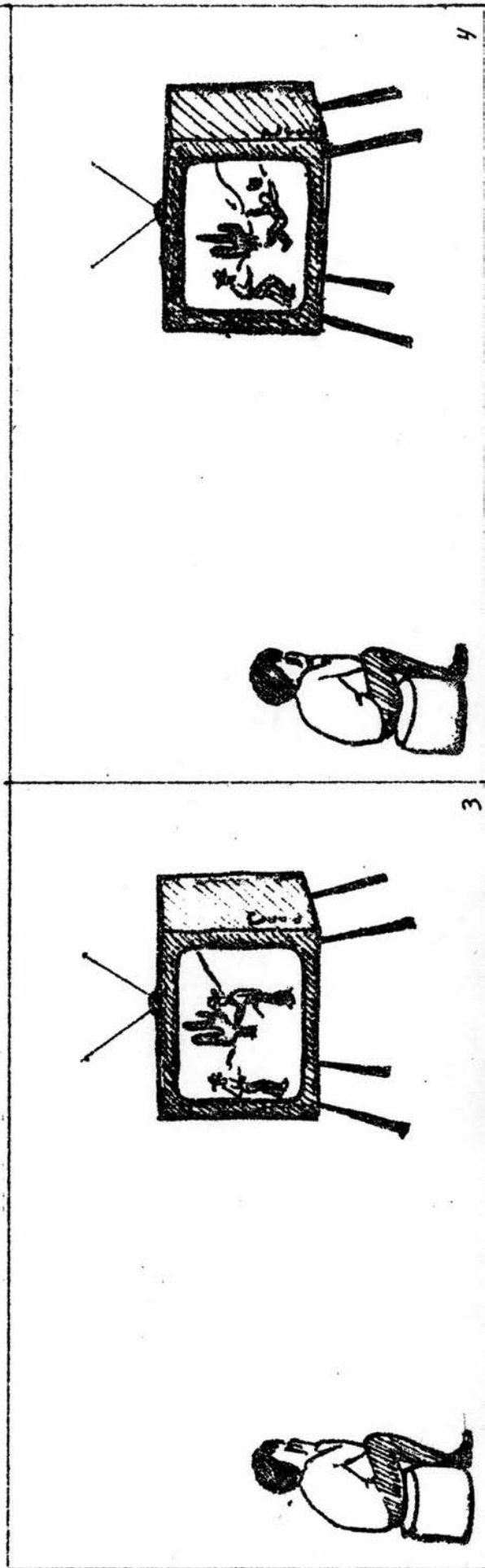
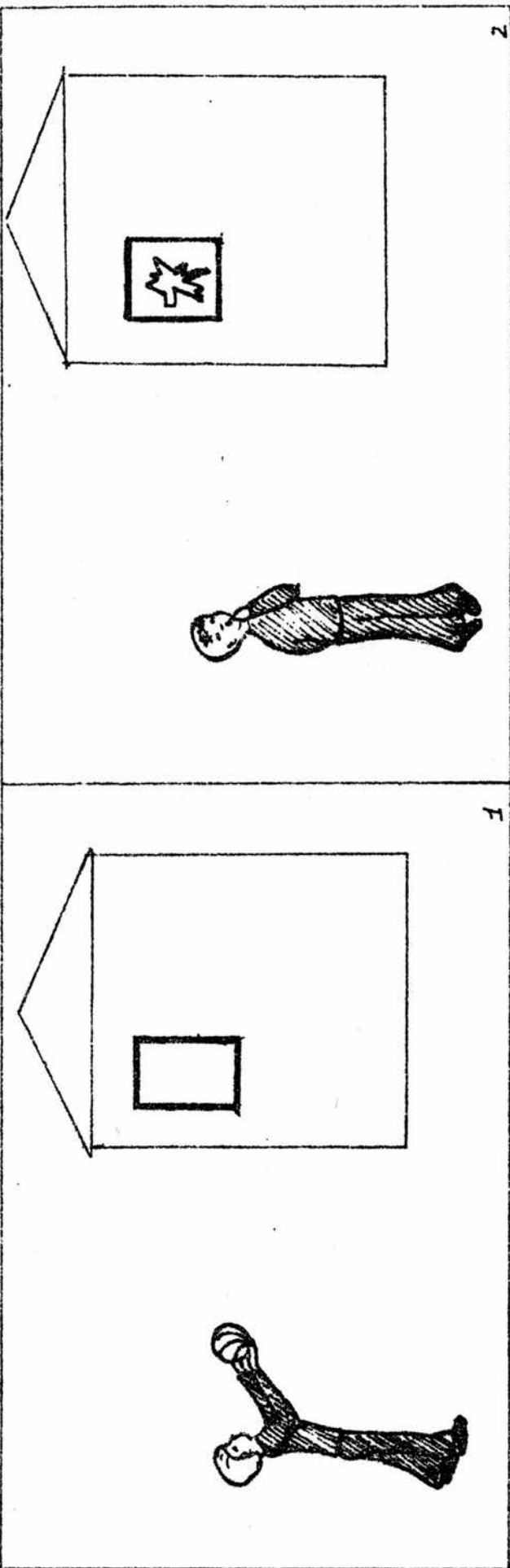
#### Subjects:

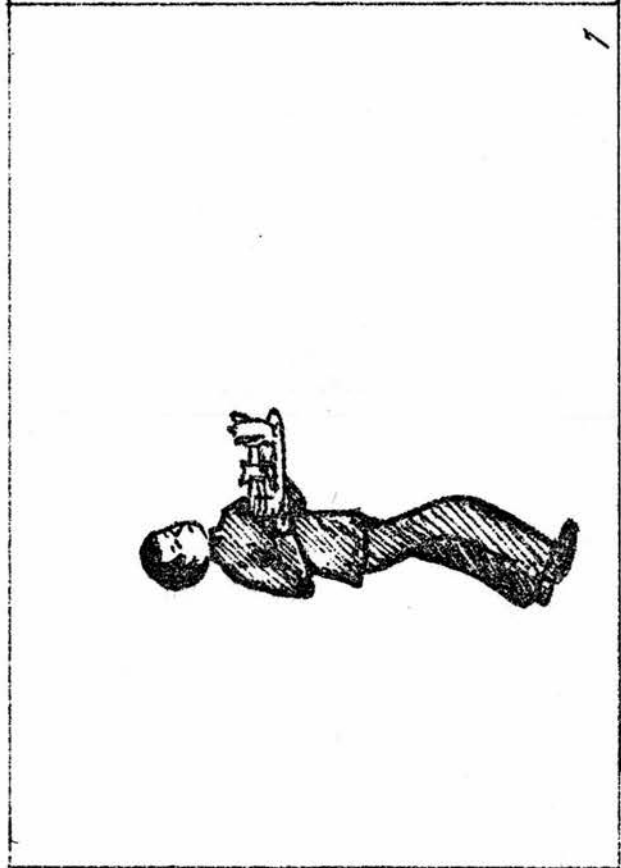
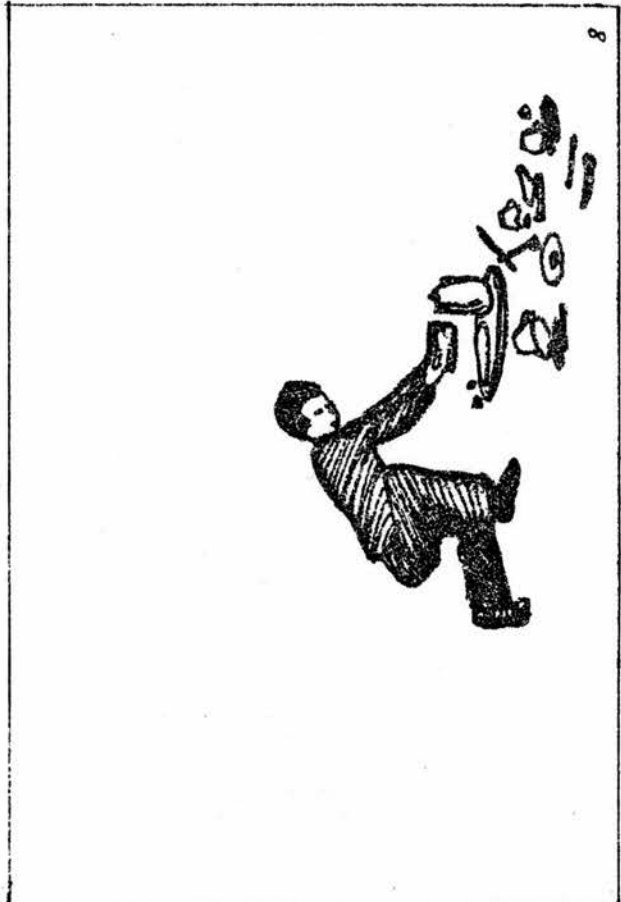
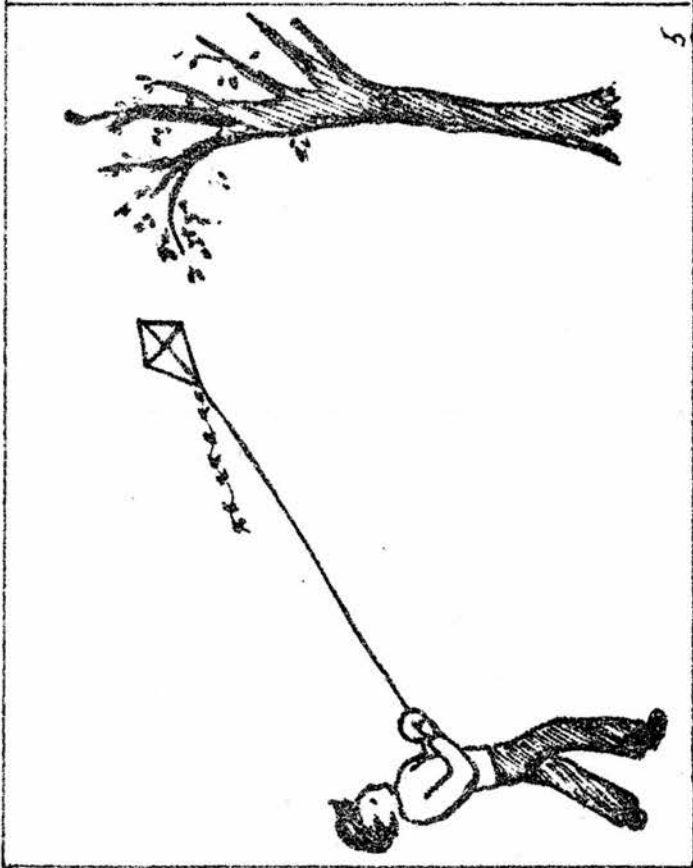
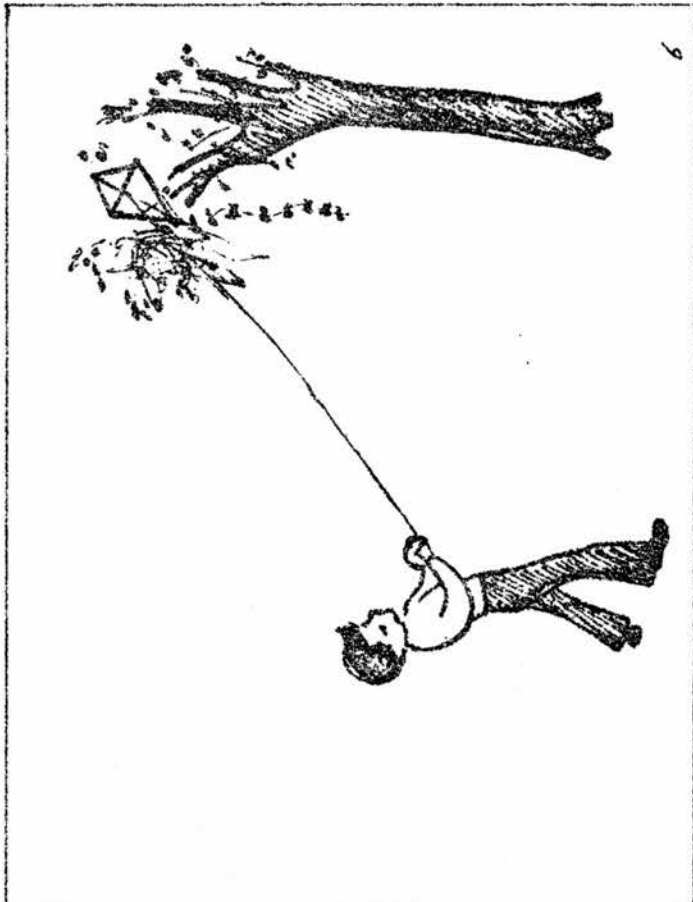
Thirty subjects were tested, their mean age was 5;10 (the youngest was 5 years old and the oldest 7;1). The sample consisted of 15 boys and 15 girls attending Primary 1 classes in two Edinburgh schools. They came from lower to middle class backgrounds and were considered by their teachers as "normal children" with some of them being "faster learners than others".

#### Procedure:

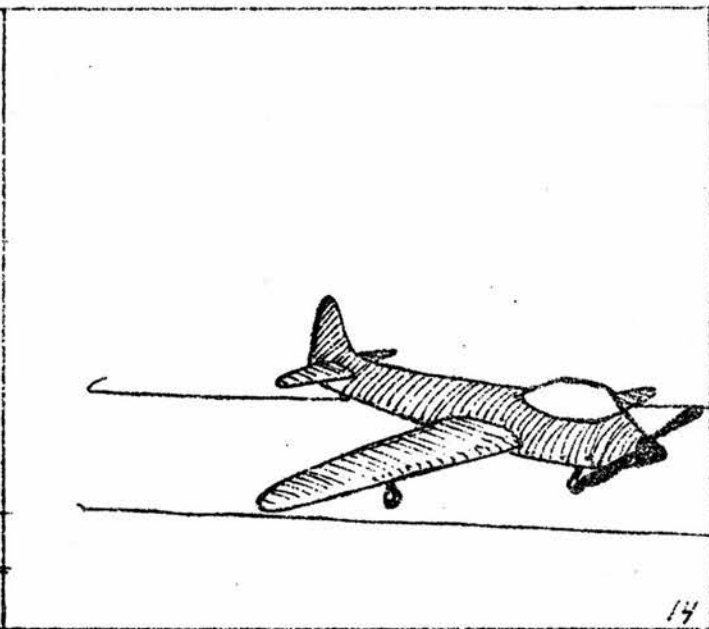
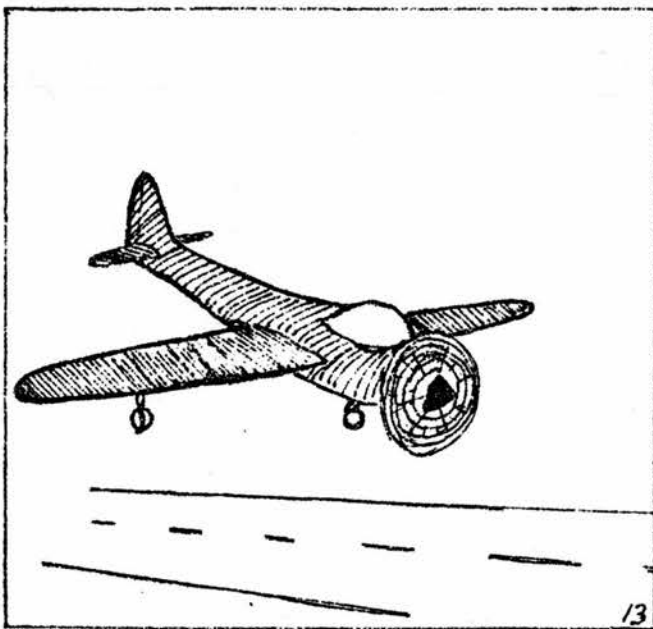
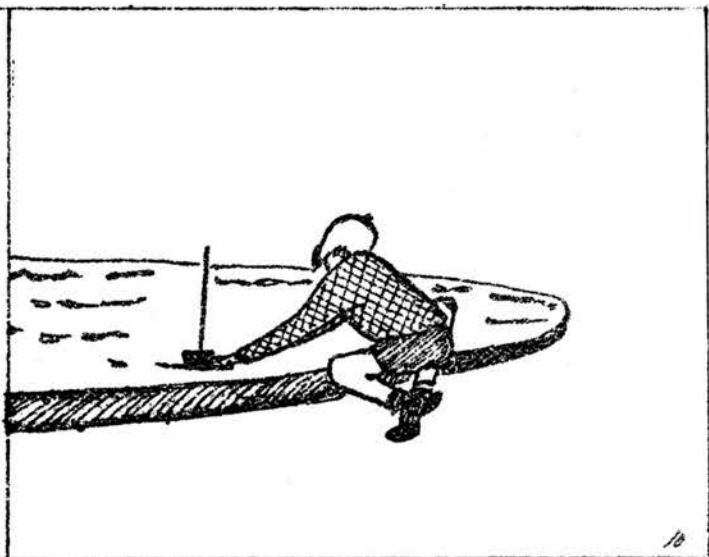
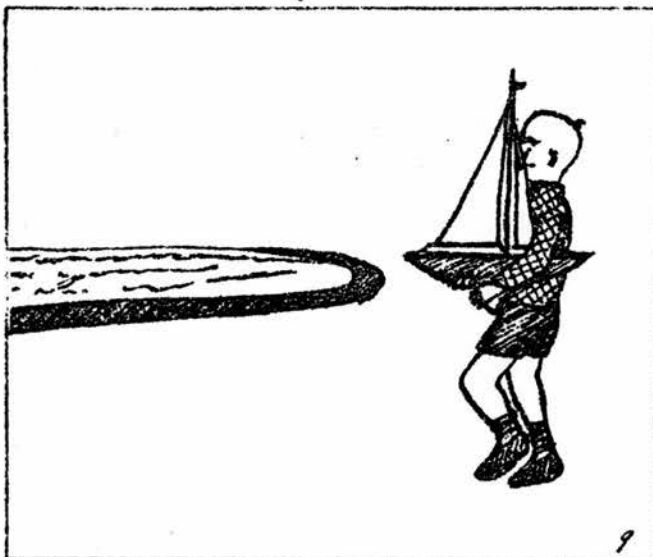
Before starting with the test per se, subjects were presented

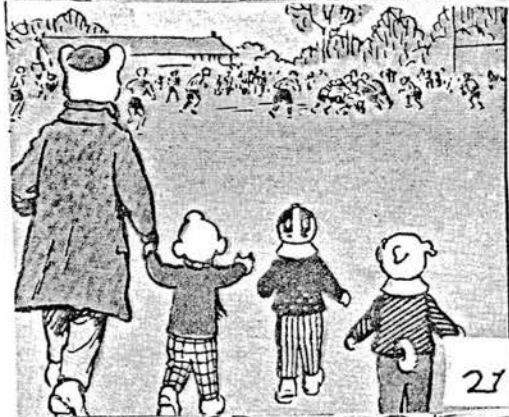
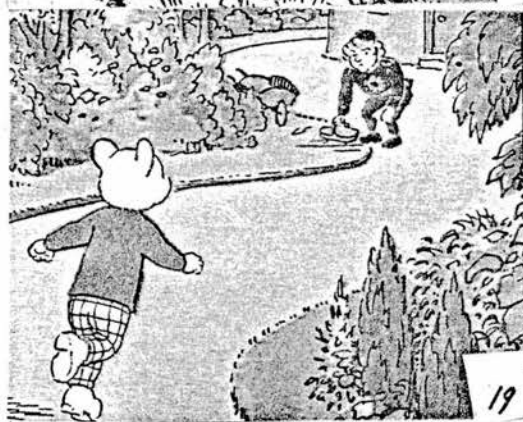
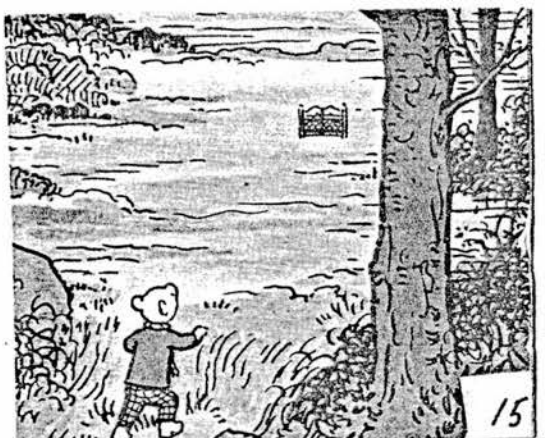
















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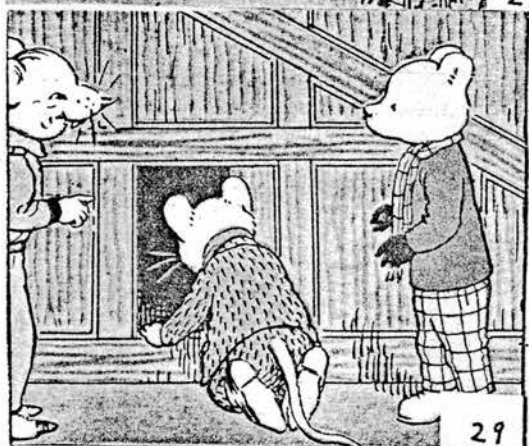
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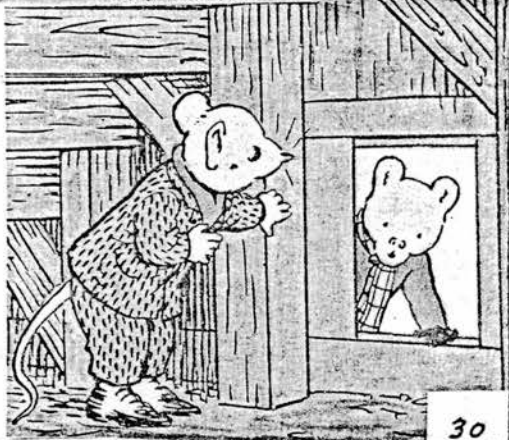
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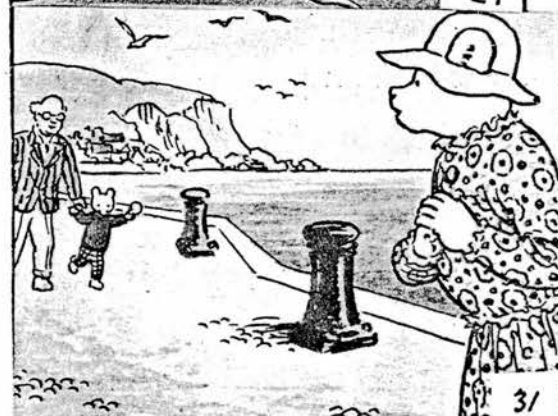
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with a pre-test. The task which the child was asked to perform involved describing a sequence of actions executed by the experimenter (putting a book on her head and putting it back on the table), then pointing at two pictures representing these actions in their order of execution and finally placing these pictures in the left-right order. For instance, the child was asked to say what the experimenter had done first and to point at the picture representing this action ("What picture shows what I did first?"). The same procedure was followed with the use of "before" and "after".

The purpose of this pre-test was to make sure that children understood the correspondence between an action and its representation in a picture as well as the correspondence between a pair of pictures in a set order (left-right order) and a sequence of events. The fact that one actor was performing the two represented actions should convince the child that the character in the two pictures was also the same. Questions with the use of "first", "before" and "after" were asked to see that their use would be understood in the instructions.

#### Presentation:

The 17 pairs of pictures were presented to each subject individually in two sessions. Since it was judged that a unique session would last too long and therefore make the child restless 7 sets were presented in one session and 10 sets in the other session. Each session lasted approximately 15 to 20 minutes. If the first session had taken place in the morning the second session would usually take place in the afternoon of the same day and if in the afternoon, the morning of the next day. Children came willingly



to "tell stories and see nice pictures".

Presentation of the 17 pairs of pictures went as follows: each picture of the pair was presented first for half the presentations, i.e. each pair was presented in the order 1-2 as often as in the order 2-1 and each subject was tested with a proportion of both types of sequences (1-2,2-1).

All subjects' answers were tape-recorded. Pictures were presented one at a time in the subject's hand to avoid any association being made between the position of the picture on the table and its position in the sequence of events.

#### Instructions:

"I will show you a whole lot of picture, these pictures are telling little stories, there are two pictures in each story, one tells the beginning of the story and the other tells the end of the story.

"In the first pictures I showed you (pre-test), I was doing something and you had to tell me which one of the two showed what I did first and which one showed what I did after .....(when subject agreed)..... "This time I won't do anything, someone else will be doing something in the pictures. You will have to find out what someone did first and what he did after. I'll give you one picture and I would like you to tell me what is happening in this picture, then I will give you the other picture and I would like you to tell me what is happening in that one too. Then I would like you to tell me which one of these pictures shows what happened first and which one shows what happened last. So you look carefully at the two pictures and try to find out which picture tells the beginning of the story and which one tells the end of the story".

Part of the instructions were repeated when the child had to make his decision until he proceeded spontaneously. After the subject had made a choice he was asked to justify his answer: "Why do you think this picture comes first in the story?" or "Why do you think this happened last in the story?".

When the child had made up his mind on the order of events, pictures were reset in the "proper" order, i.e. the pictures

representing for him the first event in the sequence was placed on the left of the one representing the second event of the sequence. This procedure was carried out for the first few sets of pictures or until the child ordered the pictures spontaneously. In most cases this convention was accepted very quickly if not immediately by the subjects. It is only in cases where children made up an "adequate" story but ordered the pictures in the wrong "physical" order that they were reminded of the convention. The only other comment made during a session was to warn a child who had been choosing the first presented picture as his first choice without giving any proper justification that the first presented picture did not necessarily represent the beginning of the story.

#### Procedure for adult subjects:

Twenty adults between ages 20-30 participated in this experiment. Most of them were University students.

#### Presentation and instructions:

The procedure with adults was more or less the same as for the children except for the pre-test. The instructions were also briefer and adults were only asked to decide on the order of events in the sequence, no description of the pictures was requested. However, comments were noted in situations where subjects hesitated to make a definite decision. Some of these subjects were then asked to classify the 17 sets of pictures along a scale of ambiguity.



## Results:

### Adults

The analysis of adults' data was twofold. First it established the most plausible sequences of events (available from the subjects' choices of the first event of the sequence). Table 4.1 displays the 17 sequences in the order chosen by adults. Odd numbers stand for the picture that was chosen as representing the first event of the sequence and pair numbers stand for the second represented event. The second column represents the numbers of subjects (on a total of 20) who chose the particular sequence. These results reveal an agreement on the sequence of events for most sets of pictures. For some sets, adults had an "ambivalent" judgement (sets 25-26 and 27-28); they hesitated before deciding on a particular order saying that depending on what one took as a reference one could choose a sequence or the other.

Table 4.1 The most plausible order of sequences of pictures as established by adult subjects.

Sets of pictures in the chosen order	Number of s's who chose this order
1-2	20
3-4	20
5-6	20
7-8	20
9-10	20
11-12	20
13-14	20
15-16	20
17-18	20
19-20	20
21-22	20
23-24	20
25-26	14
27-28	13
29-30	20
31-32	20
33-34	20

Before the second type of analysis of the data is carried out a reminder of the procedure might be necessary at this point to make Table 4.2 intelligible. Presentation of the stimuli was done in two ways: half of the presentations were in the order 1-2 (most plausible sequence) and the other half in the reverse order 2-1



(less plausible order).

Now, the second analysis carried out on adults' answers was done according to two variables: the order of presentation of pictures (1-2 and 2-1) and the subjects' choice of the sequence of events (1-2, 2-1). In Table 4.2 the vertical axis represents the two possible orders of presentation of the pairs of pictures (Presentation 1, Presentation 2) and the horizontal axis represents the two possible choices of the sequence of events (Choice 1-2, Choice 2-1) available to subjects. The distribution of adults' choices clearly demonstrates that the order of presentation has no effect on adults' choices of the sequence of events.

Table 4.2 Adult's choices according to two conditions of presentation (N=20).

	Choice 1-2	Choice 2-1
Presentation 1	164 (97%)	6 (3%)
Presentation 2	163 (96%)	7 (4%)

### Children

The total of 510 answers (17 sets x 30 subjects) were divided into correct responses and incorrect ones. An answer was correct if a child justified his choice of the sequence of events. It was incorrect if no adequate justification was given. The choice of a correct sequence (on the basis of adults' choices) with justifications such as: "I don't know", "because it is" was not judged an adequate answer. Concerning the understanding of the task, children's behavior suggested that they could master the ordering task correctly; it happened at least once for every child that a

good answer was generated by inverting the order of the pictures.

Each subject could collect a maximum of 17 points, each correct sequence counting for one point. Table 4.3 shows the individual scores of the 30 subjects divided in two age groups. The youngest group is composed of 18 children between the ages of 5 and 6 and the oldest group is composed of 12 children between the ages of 6 and 7. Scores range from 9/17 to 17/17 with an average score of  $14.6/17$  (86%). The mean for the youngest group is  $14.2/17$  (83%) and the mean for the oldest group is  $15.3/17$  (89%). A t-test shows no statistically significant difference between the scores of the two groups, however, results show a slight trend in the right direction. Both girls and boys' scores were about average with boys scoring slightly higher than the girls ( $14.7/17$  over  $14.5/17$ ), however, boys were slightly older than the girls (5;10 compared to 5;9). Therefore it appears that sex is not a determinant variable in this study.



Table 4.3 Scores representing justified choices of 17 sequences of pictures ( $N_1=18$  (age 5-6)  $N_2=12$  (age 6-7) ).

Scores $N_1$	Scores $N_2$
14	15
17	17
15	15
14	16
11	16
14	13
17	15
16	14
12	17
17	17
15	11
16	17
9	
16	
10	
15	
14	
14	
$MN_1=14.2$	$MN_2=15.3$
$MN_1N_2=14.6$	
Girls: $M=14.5$	
Boys: $M=14.7$	





This correlation implies that children do tend to pick the first presented picture as representing the first event of the sequence. This tendency is most obvious in the condition where the sets of pictures are presented in the most plausible order (1-2). It is expressed in 92% of answers (235/255) as reflected by Table 4.4. However, what becomes amazing and interesting is that in the condition where the pictures are presented in the less plausible order (2-1) 33% (84/255) of the answers are still justified which means that subjects managed to make up a good story using the pictures in their less plausible order. This "first picture effect" is even greater (although less surprising) if both justified and non-justified answers are considered: 47% (116/255). Another fact arises from Table 4.4: 53% of answers (136/255) were given by subjects who chose the most plausible order (1-2) with proper justification, in spite of the reverse order of presentation. Hence these results show that a number of children were able to pick out the most plausible sequence of events independently of the order of presentation.

Table 4.5 combines both children's and adults' results. Figures reproducing children's results have been taken from Table 4.4 and transformed in percentages while the ones representing adults' results were taken from Table 4.2. Inspection of these figures brings out the difference between the two groups concerned. Adults are clearly not influenced by the order of presentation, they recognise the most probable order.

Table 4.5 A comparison of children's and adults' choices according to two conditions of presentation (% of correct answers).

	Choice 1-2		Choice 2-1	
	Children	Adults	Children	Adults
Presentation 1	88%	97%	3%	3%
Presentation 2	53%	96%	33%	4%

Because of the smallness of children's sample and the age range of the subjects, it was impossible to obtain any statistically significant relation between the age of the young subjects and the type of strategy they used, however, there seems to be a more or less definite pattern of response as a function of age. This pattern of response was obtained from a classification of children's answers in four types of responses.

The first type of response is the non-justified choice of the first presented picture. The second type of response is the justified choice of picture 1 when the sequence is presented in the most plausible order (1-2). The third type of response is the justified choice of picture 2 when the sequence is presented in the less plausible order (2-1). The fourth type of response is the justified choice of picture 1 when the sequence is presented in the less plausible order. If a correlation is established between each type of response and the age of subjects who produced these answers, no statistically significant difference can be found, however, the



trend goes in the right direction, i.e. older subjects tend to give better answers.

When children's answers were analysed, it appeared that some sets of pictures were more ambiguous for them than others since no consensus was reached as to what order was the most plausible order. For some sets of pictures (27-28, 25-26, 29-30), the first presented picture was considered by the majority of the subjects as the first event of the sequence; for instance when pictures were presented in order 27-28, 27 would be chosen as portraying the beginning of the story while when the set was presented in order 28-27, 28 was chosen as the first event of the sequence by the majority of subjects.

Table 4.6 Degree of ambiguity of sets of pictures according to adult judges and according to children's answers.\*

Adults	Children
27-28	27-28
25-26	25-26
5-6	29-30
33-34	
13-14	2-1
17-18	12-11
15-16	18-17
7-8	10-9
31-32	14-13
11-12	8-7
** ———	4-3
1-2	32-31
3-4	6-5
9-10	
19-20	** ———
21-22	23-24
23-24	19-20
29-30	
<p>* the sets are ordered in decreasing degree of ambiguity</p> <p>** sets below the line have been judged not ambiguous</p>	



For the rest of the pictures presented in column 2 (children) of Table 4.6 "ambiguity" was linked to the order of presentation of the pictures. For instance when set 1-2 was presented in order 2-1 (less plausible order), half the subjects would choose 2 as first event of the sequence and half the subjects would choose 1 as picturing the beginning of the story. However, when the set was presented in the most plausible order (1-2) all subjects would choose 1 as representing the beginning of the story. These results show once again the effect of order of presentation of sets of pictures combined with the ambiguity of the sequence of pictures on children's choice of the picture representing the first event.

As far as the adults are concerned, a continuum of ambiguity was established and column 1 (adults) of table 4.6 represents sets of pictures in decreasing order of ambiguity; the first two sets obtained the vote for the highest degree of ambiguity. Going back to Table 4.2 the 3% and 4% of answers to Choice 2-1 were effectively responses given to sets 27-28 and 25-26. Moreover these are the only sets which did not obtain a total agreement in reference to the most plausible order (see Table 4.1). Both these results are a confirmation of adults' choices of the ambiguous sequences of pictures. As far as the other sets of pictures are concerned, adults still considered a sequence as more plausible than the other since they all favoured one against the other (100% agreement) but they claimed that it was possible to make up a different story using the pictures in the reverse order. One adult mentioned that when the first presented picture was not the first event of the sequence, it gave her a little "shock" since she expected the first presented picture to tell the beginning of the story. This comment indicates

that adults would also have a tendency to react like children but that they can control the "first picture effect" while young children cannot. For children, ambiguity is also related to the order of presentation of pictures while adults overcome this "first picture effect".

#### Discussion:

Since the average score obtained to this test is 86%, it shows that children can give a transformational interpretation of two pictures and that children in general can relate two moments of an event with proper justifications.

Results also clearly demonstrate the existence of the first picture effect on children's ordering performance. This effect is typical of some young children and not of adults.

From a classification of children's answers, four types of responses were obtained. These responses, since they follow an evolutionary pattern, can be expressed as a succession of stages. The first stage is characterised by non-justified answers; in fact, children chose the first presented picture for no reason at all.

Children belonging to the second stage can justify their choice of the first presented picture when pictures are presented in the most plausible order (1-2). The typical behavior of children belonging to the third stage is to justify their choice of the first presented picture when it is presented in the less plausible order. This means that children have to produce much more complicated stories to account for their choice if one compares these stories to the ones made up when the plausible order is used as a starting point.



To illustrate this stage here are some examples taken from some of the subjects' protocols. A young girl of 5;11 was presented with set 6-5 in this order (less plausible order). These pictures represent a boy flying a kite; in picture 6 the kite's string is tangled up in the tree while in picture 5 the kite is flying at a short distance from the tree. The adult's interpretation of the sequence is that the "boy was flying his kite and it got caught in the tree" (5-6). This appears to be the simplest and most economical way to describe the sequence of events, however, for the young girl a different interpretation was given of the sequence. When presented with picture 6 she said, "A boy playing with a kite, it got stuck in the tree", and when presented with 5 she said, "The boy got a man to help him untangle the string, he had a ladder and went up into the tree." She insisted that 6-5 was the proper sequence of the events even after it had been suggested that the events might go in the reverse order.

Another typical example of stage 3 behavior, is the response of a 5;8 girl to set 12-11 presented in that order. The pictures as described by adults, portray a girl jumping from one side of a tree to the other.

For the young subject who decided on order 12-11 (less plausible order) a more complicated justification was made up to account for her order of the sequence. She described picture 12 as a little girl playing "a jumping up and down game" and in picture 11 "she is going to try again". In fact picture 11 represents the girl as she jumps for the second time.

Following this third stage is an intermediate stage, intermediate because the subject is still influenced by the order of

presentation of pictures but starts to consider both orders as possible sequences of events before opting for the most plausible sequence of events. The fourth stage reflects a more adult like behavior: subjects look for the most plausible order of events and seem to be liberated from this "first picture effect".

When describing the method in which the first picture effect would be investigated it was suggested that if there was such an effect, the first presented picture would be chosen as the beginning of the story, such evidence was provided to confirm this hypothesis.

It also appears from the results that children's threshold of ambiguity is lower than adults' since very few sets of pictures were treated as non-ambiguous. However, this fact is probably magnified because of the child's spontaneous attitude of choosing the first presented picture. It seems that it is only in very clear situations that the child can rid himself of this tendency and behave with more objectivity.

In situations where the preoperational child is confronted with conflicting evidence (e.g. when the child has to account for the increasing level of water in a tall glass when the quantity of water stays the same) he usually is quite happy with his logically deficient justifications. At a later stage of "intuitive regulations" it is only in situations where the conflict is emphasised (when the glass becomes so long and thin that the child has to change his criterion of taller meaning "more" to taller meaning "less") that the child can come to accept the existence of two possible compensatory criteria. However, he still has not reached the operational level which is characterised by the ability to perform the "reversible operation" as Piaget claims.



In the situation where the child has to justify the order of two events in time, what is surprising is that he can manage to find a clever way to account for his choice when pictures are presented in the reverse or less plausible order while in the conservation of liquid task, the child appears to be incapable of justifying in an acceptable way the object of his centration.

As far as the age trend is concerned, results show a slight advantage of the older subjects on the younger ones but no great difference in performance was expected because of the age range of the sample.

Since the existence of the first picture effect was confirmed, further experiments should be looked upon bearing this fact in mind.

## CHAPTER 5

Children's difficulties in picture ordering tasks

Findings reported in the previous chapter demonstrated children's ability to relate two represented moments of an event in time but the order in which moments were seriated depended often on the order of presentation of sets of pictures: this behavior was labelled "the first picture effect". The first picture effect was stronger with ambiguous sets of pictures, i.e. in situations where both orders were of equal plausibility, but it remained still quite noticeable with less ambiguous sets of pictures.

Adults' decisions as to the most plausible order of sets of pictures demonstrated that very few sets indeed were very ambiguous. Ambiguity for children was very much linked to the order in which pictures were presented, i.e. when pictures were presented in the most plausible order (1-2) children all recognised this presented order as the adequate one but when pictures were presented in the reverse order (2-1) some of them would select the less plausible order (2-1) as adequate. These findings show young children's dependence on the order of presentation of pictures.

Bearing these facts in mind, experiments reported in this chapter were planned in order to minimise the first picture effect, i.e. in condition 1 (section 5.1) the child was given the "middle" picture of a three picture series first; thus, he could not select the first presented picture as representing the beginning of the story. In condition 2 (section 5.2) all three pictures were displayed in random order (not in a row) and in such a way that the child did not know which picture had been layed down first. In section 5.4



the child was presented with still more pictures (four and five picture sets) and with more or less the same procedure as for condition 2.

One purpose of the three experiments presented in this chapter was to find out what categories of errors children made when asked to order sequences of pictures. A second purpose was to find out if certain classes of transformations were easier or more difficult for children to interpret than others. In section 5.3 a comparison between the two conditions presented in sections 5.1 and 5.2 was carried out in order to see if informing the child on the position of the middle picture of the three picture set improved his performance. This piece of information should not only reduce the number of possible arrangements of pictures but it might also give the subject some indication on the most plausible order in which events occurred. Since the middle picture was designated to the child, it is possible that the interpretation of this picture at the outset of the task was sufficient to inform the child on the position of one of the two remaining pictures. If such was the case, the child only really needed to decide on the position of one of the two remaining pictures to obtain the sequence.

In the experiment reported in section 5.4 the child was given a starting point from which to begin his sequence (designation of the position of the first or last picture of the series). However the number of possible arrangements of pictures is not reduced as in condition 1 (section 5.1) since sets of pictures contain four or five pictures. It is expected, on these grounds alone that subjects' performance in this task should be inferior to their performance in the two previous conditions (section 5.1 and 5.2).

An analysis of subjects' protocols should also provide more information on the categories of errors produced by different classes of transformations as well as some indication on the role of context in picture ordering tasks.

5.1 Ordering three pictures in an adequate sequence: the middle picture of the sequence is designated to the child. Condition 1.

Material:

Nineteen sets of three pictures were presented to subjects, 11 sets were taken from Rupert the Bear Albums (Daily Express Annuals 1972-1973 publications) and eight sets were coloured line drawings (they are presented on the following pages). These sets represented various classes of transformations (a classification of sets of pictures according to the classes of transformation they represent will be made available in Table 5.1.3).

Subjects:

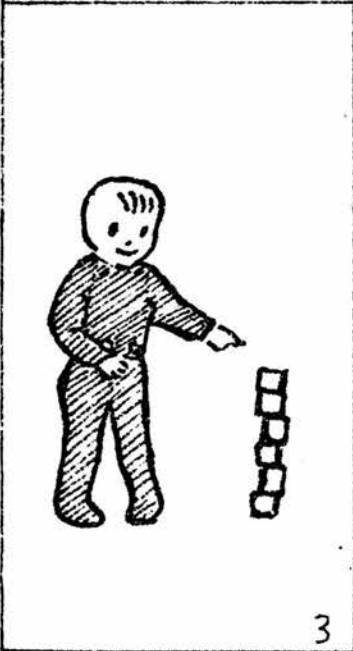
Twenty-one subjects between ages 5;1 and 6;7 (average age 5;8) were tested with the 19 sets of pictures. These subjects had been used in the experiment reported in chapter 4.

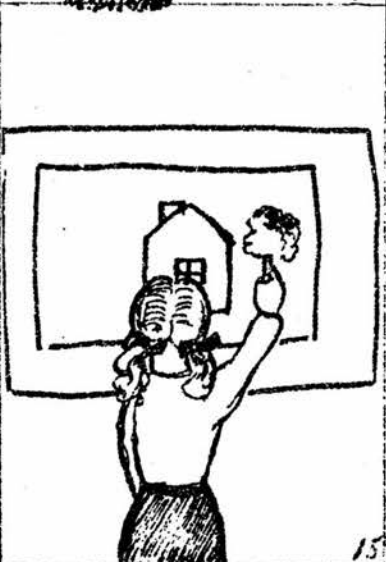
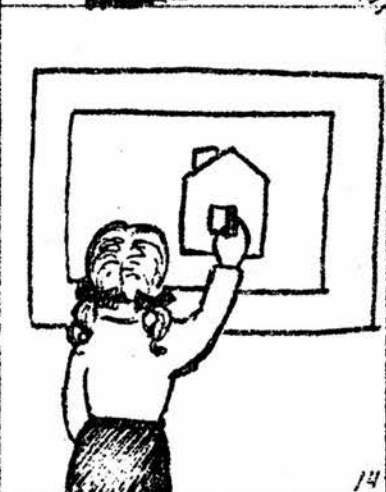
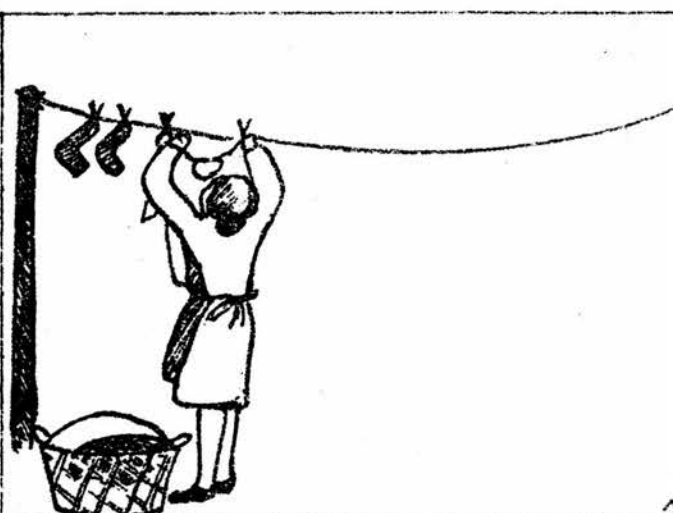
Procedure:

Subjects were seen individually and presented with the 19 sets of pictures. A session lasted approximately 20 minutes and all responses were tape-recorded.

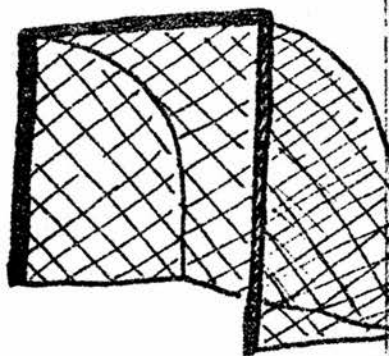
The child was given the second frame of the series first and asked to describe it, then he was presented with the two remaining frames in random order. After the child had made his choice he was asked to justify it.







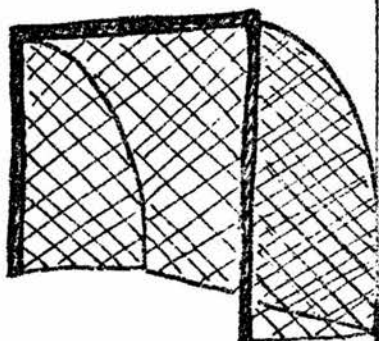




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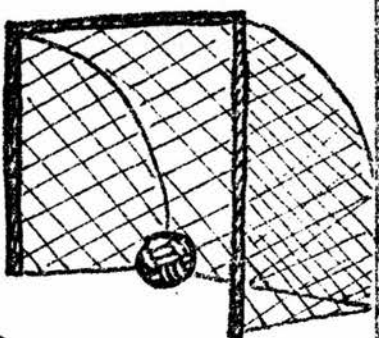
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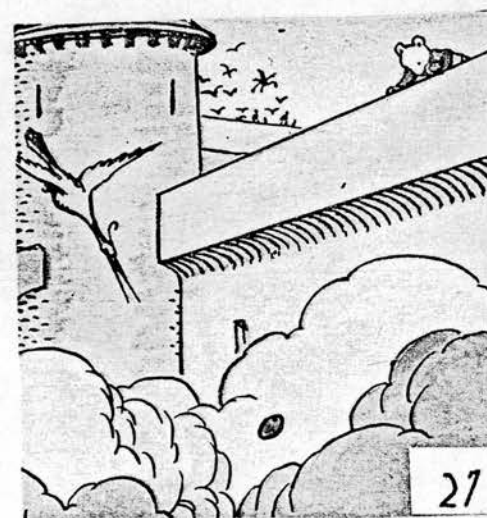
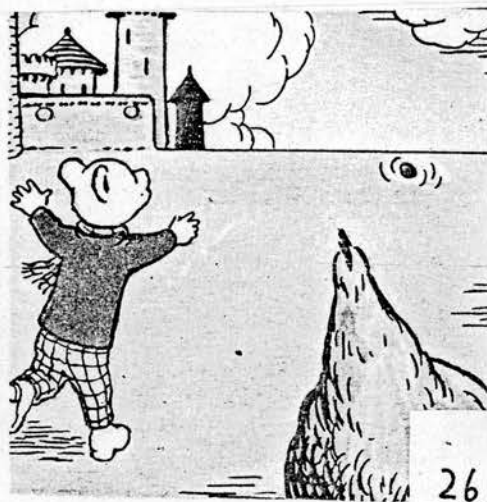
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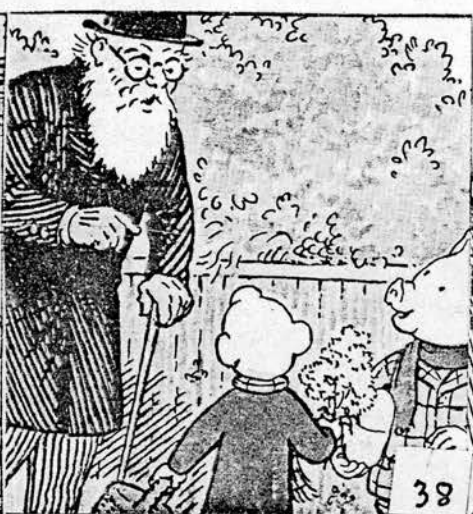
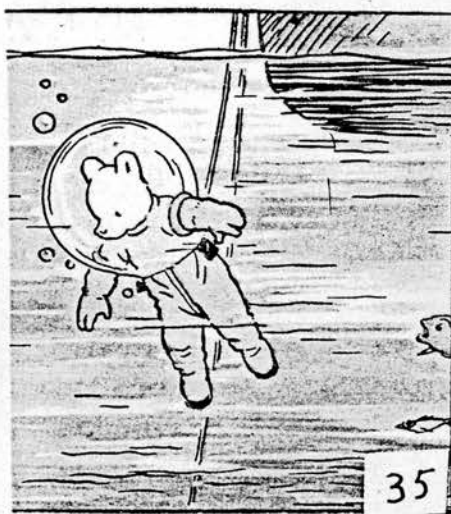
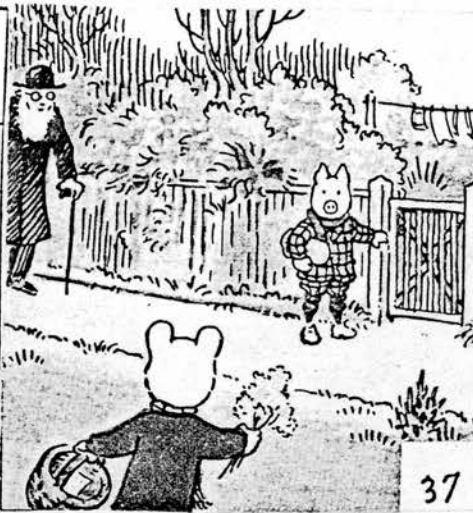


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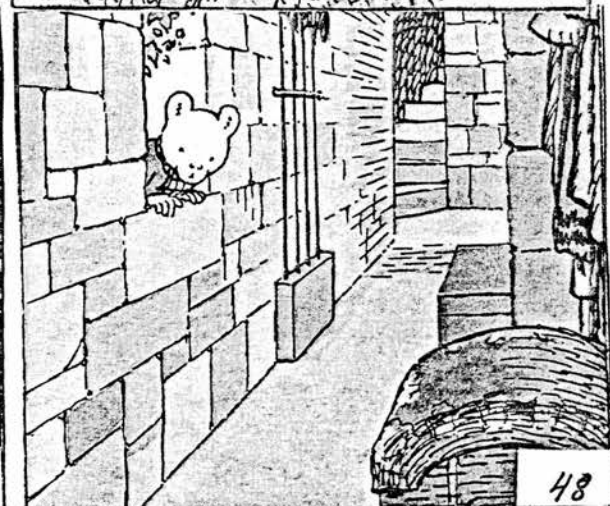
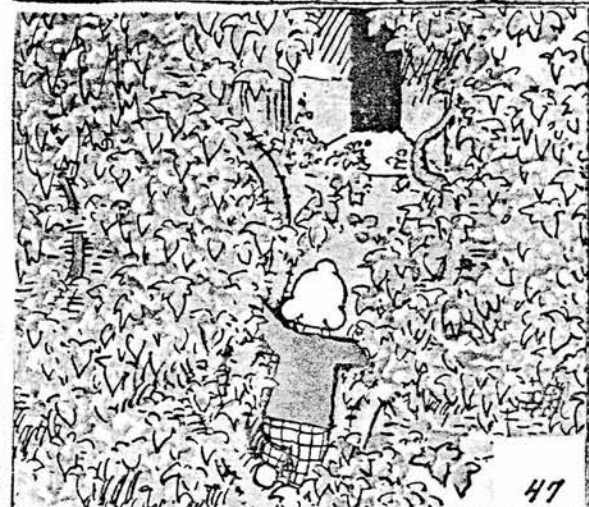
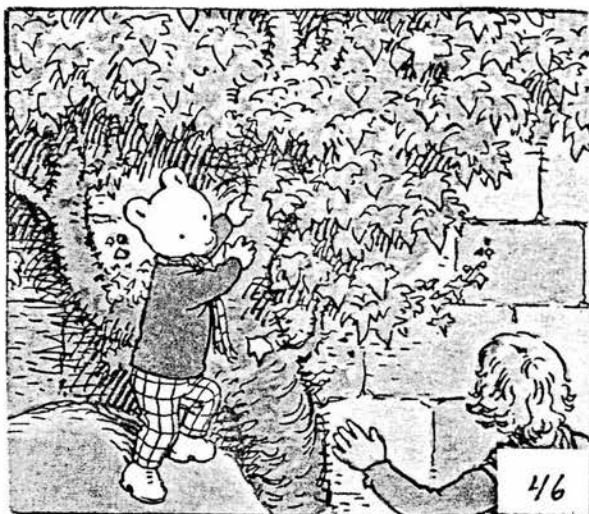


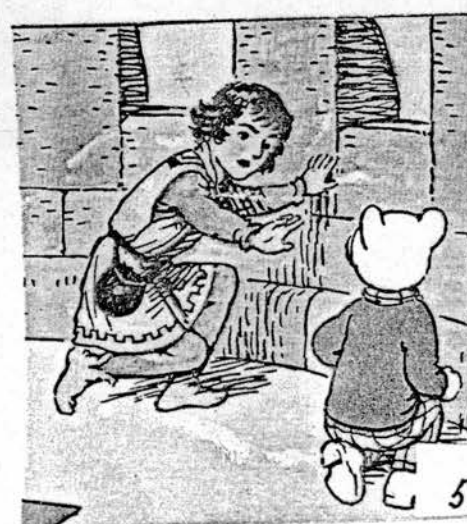
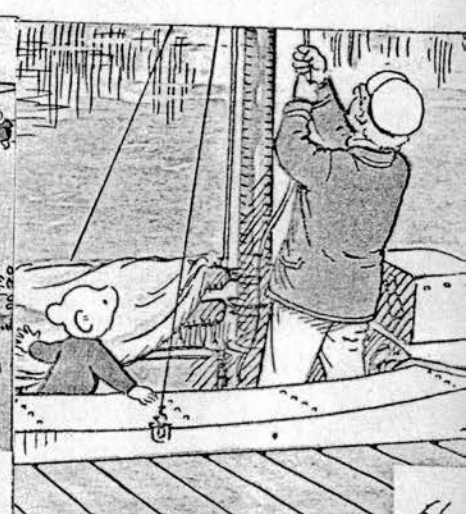
24













Instructions:

Before instructions were given, the child was asked to give an account of the tasks he had been given in a previous session (chapter 4). He was reminded of the pre-test and of lining-up pictures in a row to make up a story if he had not recalled explicitly those procedural details.

Instructions as such were as follows:

"This time I will show you three pictures. I will tell you which picture is the middle picture of the row and you will have to find out which picture comes first and which picture comes last. Look carefully at all the pictures and try to make up a little story. Try to find out which picture tells the beginning of the story and which one tells the end of the story. I will put the middle picture here, you put the picture that tells the beginning of the story on this side (left) and the one telling the end of the story on that side (right)."

If the child made up the appropriate story but did not order pictures in the proper sequence, he was asked to point to the picture telling the beginning of the story and to point to the one representing the end of the story. He was also reminded of the instructions, "On which side did I say the picture telling the beginning of the story went?" After pictures had been ordered the child was asked to justify his choice of sequence:

"Why do you think pictures go this way?", "Why does this picture tell the beginning of the story and this one tell the end of the story?"

Results:

Subjects appeared to understand instructions concerning the physical order of sets of pictures since they pointed to the appropriate pictures when asked, "Which one tells the beginning of the story and which one tells the end of the story?"



A total of 399 answers (21 X 19 sets) were analysed in terms of appropriate order and adequate justifications of choices (any order which could be logically justified was considered adequate). Table 5.1.1 displays the 21 subjects' scores. The first column represents the spontaneously adequate choices (Sp.A.C.), the second column represents the corrected choices (C.C) and the third column the inadequate choices (I.C.).

Table 5.1.1 Scores of the 21 subjects on the first condition of the three picture ordering task (19 sets of pictures = 19 data points).

Subjects	Sp.A.C.	C.C.	I.C.
A	15	2	2
B	19		
C	18	1	
D	18		1
E	17	2	
F	18	1	
G	15	3	1
H	11	3	5
I	16	3	
J	19		
K	19		
L	19		
M	18	1	
N	16	3	
O	19		
P	17		2
Q	18	1	
R	18		1
S	16	2	1
T	16	3	
U	16	3	
Total:	358 — 399 (90%)	28 — 399 (7%)	13 — 399 (3%)
Average score: 17/19			

The individual average score is 17/19 adequately justified choices. If second choices are accepted as good answers, the average individual score going up to 18.3/19.

#### Categories of errors:

Subjects' choices which were not spontaneously and adequately justified, (i.e. C.C. and I.C. answers totalling 41/399 choices) were analysed and classified into five main categories of errors. Definitions of these five categories follow with examples illustrating each definition. The percentage of errors corresponding to each category of error are compiled in Table 5.1.2.

Category 1: Wrong cue: the order of events is decided using an irrelevant cue. For example, subjects presented with set 7-8-9 (representing a man working at a desk with a candle burning on the corner of the desk) ordered the series in the reverse order 9-8-7. They justified their choice by saying that the flame was becoming "bigger and bigger" instead of using the size of the candle as a cue.

Category 2: Illogical continuity: a certain continuity is seen between moments but it is incoherent. For example, subjects presented with set 49-50-51 (representing Rupert and a friend at the top of a staircase trying to open up a trap door; they open it up and they come out at the top of the castle) ordered the series in the reverse order 51-50-49. They justified their choice saying that; "they were trying to go in and then they were out" or else that "they got up and then they were trying to get up".



Category 3: Centration on one cue or one event: only one cue (or one event when applicable) is considered when two or more cues should be used. For example, subjects presented with set 4-5-6 (representing a man cutting a hedge into the shape of a peacock) centered on the changing shape but did not consider the decreasing quantity of leaves.

Category 4: No continuity: events are described independently, they are not related to a common context. For example, subjects presented with set 13-14-15 (representing a little girl drawing a picture of a house, then she adds a window and then a tree) order the series in the reverse order. They justify their sequence by saying that all three pictures are individual ones, "it isn't the same drawing".

Category 5: The cue is unused: For example, a subject presented with set 10-11-12 (representing a dog digging and finding a bone then holding it in its jaw) chooses to order the pictures in order 12-11-10. He justifies his choice saying that the dog had a bone and that he was jumping over and over. This child did not use the bone as a cue (in picture 11) to decide on the sequence of events.

Table 5.1.2 Percentage of errors obtained for the five categories of error (total number of errors: 41/399 choices).

Categories of error	Percentage of spontaneously inadequate choices
1 Wrong cue	27%
2 Illogical continuity	22%
3 Centration	27%
4 No continuity	10%
5 Cue unused	7%

Results displayed in Table 5.1.2 show that the most common error made by children concerns picking up the right cue (i.e. category of error 1-3 and 5 totalling 61%).

A few subjects' spontaneous choice of moment 1 of the sequence was for the second frame (4% of all cases made this choice). However, when subjects were reminded that frame 2 represented moment 2 most subjects revised their answer (1% of cases remained unchanged.)

The first presented picture, picture 2 was usually correctly interpreted by subjects; in 13 cases, however, subjects' interpretations could have led to misinterpretations of stories. In seven of these cases the first interpretation was revised when the two other pictures were presented. Four of the six other inadequate interpretations which were not revised when the two remaining pictures were displayed produced inadequate sequences.

Another analysis of results was carried out. This time each set of pictures was matched with the percentage of adequate answers it obtained. Along with this score, each set was also matched with the class of transformation it portrayed. The purpose of this analysis was to find out if some classes of transformations were easier to interpret than others.

Table 5.1.3 displays numerals representing sets of pictures in the first column. The second column represents the corresponding class of transformation and the third column the average score obtained by the 21 subjects to each set.



Table 5.1.3 Scores obtained for different classes of transformations (19 sets of pictures)

Sets	Transformation	Score
1-2-3	Size	85%
4-5-6	Shape-quantity	76%
7-8-9	Size	71%
10-11-12	Existence *	90%
13-14-15	Quantity	95%
16-17-18	Quantity	100%
19-20-21	Distance	95%
22-23-24	Quantity	90%
25-26-27	Position	90%
28-29-30	Position	80%
31-32-33	Distance	100%
34-35-36	Position	100%
37-38-39	Distance	85%
40-41-42	Distance-orientation	62%
43-44-45	Position-orientation	100%
46-47-48	Position	100%
49-50-51	Position	85%
52-53-54	Distance	95%
55-56-57	Distance-height	95%
* presence or absence		

Transformations represented in some of these sets are difficult to label such as the ones taking place in sets 43-44-45. In some cases a set could have been labelled with a different class of transformation or more than one class of transformation. For instance, the classification of set 37-38-39 into the distance transformation class is not totally adequate since this classification does not account for the "flower" cue, (see pictures). However, this set was labelled with the distance transformation class because distance appeared to be the most necessary cue to consider in this case (a few adults were asked to make a judgement on what they considered the most relevant cue to be used to order the sets of pictures). The reader should therefore be warned that this classification is not always exhaustive and precise.

Since the average score obtained to these sets of pictures is fairly high (the average individual score being 90%, see Table 5.1.1) it is difficult to see if certain classes of transformations are more difficult to interpret than others. The set which obtained the lowest score is set 40-41-42 (62%). Subjects had difficulty in detecting continuity in this set, they did not seem to grasp the context of the sequence. Some of them would pick up an irrelevant cue to justify their order. For many children picture 42 was not clear, they were undecided on the fact that the girls were coming or going away when questioned about it.

Since a more extensive discussion will follow in section 5.3 where condition 1 and condition 2 will be compared (condition 2 presents the same material except that subjects are not informed of the position of the second frame of the series), only a few comments on these results will be expressed in the following paragraphs.

### Discussion:

First of all, it was noticed that the "first picture effect" which was observed in the two-picture situation (chapter 4) was generally avoided in the three-picture situation probably because of the different procedure. In the two-picture situation many children could find proper justifications for sequences of pictures organised with less plausible order. In the three-picture situation subjects gave acceptable justifications almost uniquely when pictures were seriated in the most plausible order. The fact that the position of picture 2 was already decided probably reduced the plausibility of one order in favour of the other. Moreover, the simple fact that children could not find an acceptable justification for the reverse order (3-2-1-) suggests that sets of pictures were less ambiguous in the three-picture situation than in the two-picture situation where subjects could justify both orders.<sup>4</sup>

The high scores (90%) obtained in the three-picture situation indicate that children can relate the middle moment of a sequence to the antecedent moment and to the subsequent moment in a situation where the position in time of the second frame is already established. However, in the two experimental situations already described (chapter 4 and chapter 5, section 5.1) the child's task was simplified either because almost any sequence of events could be justified (chapter 4) or the number of possible arrangements of pictures was greatly

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<sup>4</sup>A few adults were consulted about the degree of ambiguity of sets of pictures and only set 43-44-45 was treated as ambiguous. With the series of pictures used in chapter 4 adults had classified a greater number of sets as possibly ambiguous. In this case both adults and children seem to agree on the plausibility of one particular order, while in chapter 4, children appeared very much influenced by the order of presentation of sets of pictures.



reduced (six possibilities reduced to two in the condition reported in section 5.1).

In the next experimental situation, no such help was given to the child. One could therefore have predicted that more errors would be committed and since the same stimuli were presented, one would have expected subjects to make the same type of errors. The fact that the child was given no starting point from which to organise his sequence and the actual increase of possible arrangements of pictures (two to six) might have augmented his difficulty to see the continuity of the sequences.

## 5.2

### Ordering three pictures in an adequate sequence. Condition 2

#### Material:

Twenty sets of pictures were presented to subjects, 19 of these sets were utilised as stimuli in the previous condition reported in section 5.1. The first set (the extra set) was used as a trial set to check that instructions had been properly understood.

#### Pre-test material:

Plasticine was used to make a ball, a sausage and a pancake. These shapes were produced by the experimenter and the child had to identify them in pictures representing the experimenter holding a ball, a sausage or a pancake, (i.e. three pictures presented on the following page).

#### Subjects:

Twenty subjects between ages 5;2 and 6;7 (average age 5;9) were tested with sets of three pictures. These "naive" subjects came from three Primary 1 classes in an Edinburgh school serving



1



2



3

lower and middle-class socioeconomic areas. They were considered as "normal" children of average intelligence by their teachers.

#### Procedure:

##### Pre-test:

Since subjects were not familiar with the picture ordering tasks, a pre-test was given to them before the test proper. This pre-test was of the same type as the one used in the experiment reported in chapter 4. It consisted of describing a sequence of actions executed by the experimenter (transforming a piece of plasticine into a ball, a sausage and a pancake) and of identifying pictures representing these actions in the order in which they had been performed. Finally, subjects were asked to order pictures in the left-right order according to the order of execution of actions.

##### Test:

Subjects were presented with the 20 sets of pictures during a 20 minutes session and all responses were tape recorded. The three pictures were presented almost simultaneously in a random pattern (not a row) so that children only saw the three pictures once they had been displayed on the table. This procedure was adopted to avoid subjects making an association between the order of presentation of pictures and their position in the sequence of events. The child was asked to consider each group of three pictures as individual stories and as representing someone performing a sequence of actions. He was told that, as he had just done in the pre-test, he would have to decide what the person had done first, next and last and to order pictures accordingly.



### Instructions:

"I will show you some pictures, these pictures are telling little stories; there are three pictures in each story. In these pictures, somebody is doing something and you have to find out what that someone did first, what he did next, and what he did last. Then, I want you to make a row, a line with the pictures the same way we did with these pictures (showing pictures used in pre-test). You put the picture that comes first in the story on this side of the table (left), the one that comes next beside the first one and the one that comes last, at the end of the line (right). Now, you look carefully at all the pictures and you try to make up a little story."

If the child made up a story which did not correspond to the pictures' order, he was asked to point out the picture representing the beginning of his story, the middle and end of his story and reminded of the instructions.

Once the child had seriated a set of pictures, he was asked to justify the chosen order,

"Why do you think pictures go like this? Why does this one come first in the story, this one second and this one last?"

### Results and discussion:

Most children succeeded in ordering the first set of pictures (extra set) adequately on first trial. When reminded of the pre-test, subjects who had 'misordered' pictures managed to reorder the set on their own.

A total of 380 responses (20 subjects X 19 sets) were analysed and scored according to the type of justification given to the chosen order. A response was correct only if it had been adequately justified by the child. Table 5.2.1 displays the 20 individual scores. The first column of numbers represents spontaneously adequate choices (Sp.A.C.), the second column represents corrected choices (C.C) and the third column represents inadequate choices (I.C.), i.e. choices which had not been adequately justified.

Table 5.2.1 Scores of the 20 subjects on the second condition of the three picture ordering task (19 sets of pictures=19 data points).

Subjects	Sp.A.C.	C.C.	I.C.
A	17	2	
B	18	1	
C	9	7	3
D	10	5	4
E	11	5	3
F	13	6	
G	8	5	6
H	10	1	8
I	14	2	3
J	15	2	2
K	11	3	5
L	11	2	6
M	14	2	3
N	17	1	1
O	12	2	5
P	11	3	5
Q	17	1	1
R	16	2	1
S	18	1	
T	14		5
Total:	266	53	61
	<u>380</u>	<u>380</u>	<u>380</u>
	70%	14%	16%
Average score 13.3/19			

The individual average score is 13.3/19; if scores include answers which have been corrected spontaneously or with E's intervention, the average individual score goes up to 16/19.

The types of intervention which were made when the child's first answer was wrong varied with sets of pictures. A response only obtained a C.C. score (corrected choice) if the child corrected his first response spontaneously or if only one suggestion was made to direct the child's attention to the relevant cue. If a series of questions needed to be asked before the child gave a proper answer, the answer was scored incorrect. The following examples illustrate the types of intervention made.

A child ordered set 7-8-9 in the reverse order 9-8-7. He described this sequence as representing a candle flickering more and more. After he was asked: "What happens to candles when you light them?" the child reordered the series in the reverse sequence 7-8-9 (i.e. the appropriate one) saying that "it's big and it gets smaller".

Another child ordered set 22-23-24 (a man eating a chicken) in the reverse order justifying her choice as follows: "He is waiting for it, he starts, he is eating". When asked, "What's in his plate (in picture 24)?" the child answered "bones" and after a few seconds reversed her choice. She says she had not seen the bones at first.

After ordering set 31-32-33 in the reverse order, a child explained that: "Rupert is asking if he can go with his friend, Rupert's friend is asking his mummy and they are going away". When this child was asked if Rupert and his friend were going away or coming in picture 31 the child said they were coming and changed the order: "They are going to the mummies, they are nearer, Rupert's pal is going."



Many errors which are corrected afterwards are due to children's too rapid decisions. A second look at their choice (i.e. when the time comes to justify it) is often sufficient to elicit an adequate response.

#### Categories of errors:

The same categories of errors were found in this condition as were found in condition 1 (section 5.1), though one more category was added to the preceding classification; category 6.

Category 6: Excluding pictures from a sequence: this type of error is produced when a subject considers only two of the three pictures of the series because he cannot fit the third one in his story. For instance, a child seriated set 10-11-12 (representing a dog digging for a bone which he then holds in his mouth) in order 10-12-11 and told the following story: "He is digging for his bone, he got it." Picture 11 was not mentioned in the story and was relegated to the end of the row. (It is a common practice for children to place pictures they cannot fit in a series at the end of the row.)

Table 5.2.2 represents the percentage of errors obtained for the six main categories of error: category 1: wrong cue, category 2: illogical continuity, category 3: centration on one cue, category 4: no continuity, category 5: cue unused, category 6: excluding pictures from the sequence. All these categories of errors have been defined in the preceding section under the heading categories of errors.

Table 5.2.2 Percentage of errors obtained for the six categories of error (total number of registered errors: 114/380).

Categories of error	Percentage of spontaneously inadequate choices
1 Wrong cue	17%
2 Illogical continuity	3%
3 Centration	14%
4 No continuity	31%
5 Cue unused	17.5%
6 Excluding pictures from a sequence	6%

Another type of error which was observed in three cases is that children made a row with the three pictures just presented without spending any time analysing them and tried to justify this arbitrary order (e.g. the child would bring the pictures closer to him immediately after the presentation making a row as he was bringing them closer).

The category of error which is responsible for the highest percentage of incorrect answers is category 4 error (no continuity). Indeed some children had difficulty in co-ordinating the three represented moments of the event. They would describe each picture independently and no apparent effort was made to relate pictures to each other. Often children would place one picture beside the other picture sharing a common background and place the remaining one at the end of the row.

When justifying their choice of sequence children generally used the first represented moment as the reason for the chosen order of pictures (92%).

If subjects' scores are divided into two groups according to age (group 1:5-6 years (N=14), group 2:6+ years (N=6)) the younger group obtains an average score of 12/19 while the older group obtains a score of 14.4/19. The small difference in these scores cannot allow us to draw any conclusions about the competence of the older subjects relative to the younger ones, but since older subjects do score slightly higher than the younger ones these results show a trend in the expected direction.

#### Classes of transformations:

Table 5.2.3 reproduces classes of transformations shown previously in Table 5.1.3 (section 5.1) with in this case the appropriate corresponding scores.



Table 5.2.3 Scores obtained to different classes of transformations.

Sets	Transformations	Score
1-2-3	Size	90%
4-5-6	Shape-quantity	70%
7-8-9	Size	20%
10-11-12	Existence	65%
13-14-15	Quantity	90%
16-17-18	Quantity	95%
19-20-21	Distance	70%
22-23-24	Quantity	40%
25-26-27	Position	80%
28-29-30	Position	90%
31-32-33	Distance	60%
34-35-36	Position	70%
37-38-39	Distance	80%
40-41-42	Distance-orientation	60%
43-44-45	Position-orientation	80%
46-47-48	Position	45%
49-50-51	Position	80%
52-53-54	Distance	70%
55-56-57	Distance-height	80%

A study of Table 5.2.3 reveals the existence of low and high figures. These two particular groups of figures correspond to various classes of transformations. If scores are matched with

classes of transformations one should be informed of the "level of difficulty" involved in interpreting certain classes of transformations. Sets which obtained scores over 90% were therefore classified in the "highest" score category, i.e. sets 1-2-3, 13-14-15, 16-17-18, 28-29-30. These sets represent transformations which can be classified as quantitative transformations (1-2-3, 13-14-15, 16-17-18) and position transformations (28-29-30). These results suggest that children can interpret relatively easily certain quantitative transformations and changes of position.

Now, assembling sets which obtained the lowest scores (i.e. sets for which less than half the subjects could justify appropriately the chosen order) one finds that sets 7-8-9, 22-23-24, 46-47-48 belong to this category. These sets can be classified in the quantitative transformation class (7-8-9, 22-23-24) and the position transformation class (46-47-48).

At first sight, these results pose something of a dilemma since both high and low scores are obtained by the same classes of transformations. If errors to sets 7-8-9 and 22-23-24 are classified according to the type of errors expressed in Table 5.2.2 subjects made errors because they "attended to the wrong cues". For set 7-8-9 they attended to the size of the flame instead of the size of the candle and with set 22-23-24 they attended to the boy's attitude (not eating-eating) instead of the amount of chicken in his plate. When questioned about these answers many children changed their first chosen order for the appropriate one (these corrected choices bring the score up to 75% for each one of the sets). As far as set 46-47-48 is concerned, many children had difficulty in seeing the continuity of these three moments; they usually managed to link the

two first pictures but picture 48 was left out of the series. One of the reasons which might explain why picture 48 was left out is the change of background in this frame.

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Line-drawing series (picture 1 to 24) have constant backgrounds and represent various classes of transformations. The average score obtained with these sets of pictures is 68%. Rupert the Bear pictures have changing backgrounds but most of these changes are "zoom effects", i.e. the scene is represented as "close" or "far" from the imaginary observer. For example, the scene represented in set 28-29-30 has the same background in all three frames except that the observer is closer to the scene in picture 29 than in picture 28. Background and perspective changes are combined in sets 25-26-27, 31-32-33, 37-38-39 and in situations such as the ones pictured in sets 46-47-48 and 43-44-45, one of the three pictures represents a moment of the event which is set in a different background. If the average score obtained for sets in which changes of background and changes of perspective took place (all the Rupert the Bear pictures except set 28-29-30) is compared with the average score obtained by sets displaying a constant background and perspective (i.e. line-drawings) the difference obtained is 3% (71% - 68%). Judging by these results, the reason why children do not appear to be disturbed by these changes of perspective is possibly that the general background of pictures remains essentially the same throughout the three pictures (except for sets 43-44-45 and 46-47-48). However, when the change of background is important, as in picture 48 of set 46-47-48, some children find it difficult to fit such a picture in the series. As far as set 43-44-45 is concerned, the



fact that these pictures can be ordered in two sequences with proper justifications probably attenuates this disturbing effect.

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An analysis of children's descriptions of pictures in terms of events and relations demonstrates how children can pick up in 2-dimensional information the laws of shape and size constancy and the laws of perspective which they have learned to follow with 3-dimensional information. A few examples will illustrate children's competence to interpret 2D information in much the same way as adults do. Each following paragraph will be entitled by the numerical label given to each set concerned.

Set 31-32-33: Subjects were able to recognise the identity of the "mothers" in pictures 31-32 even though many cues have been removed. They also interpreted the change in size of characters in pictures 31-32 as a change of distance.

Set 34-35-36: Subjects were able to recognise a boat in picture 35 even though only a small portion of the boat was seen; the cue was sufficient for picture completion.

Set 49-50-51: Even though the trap door represented in the three pictures is of different colours, children still recognised it as the same.

Set 52-53-54: A change of relative size is again interpreted as a change of distance and the fact that "the man's back" is seen in picture 54 suggests to children that the man is "going away".

Set 25-26-27: Picture 25 represents a side view of Rupert the Bear kicking a ball. Even though the action is portrayed from this particular angle (side) subjects were still able to decode adequately the spatial relation between Rupert and the ball, i.e. they described

the frame as "Rupert kicking the ball ahead of him". Children can therefore conserve the spatial relation between two objects when represented from various perspectives.

### Discussion:

Before results of sections 5.1 and 5.2 are compared, let us recapitulate the main points which have been drawn from the analysis of subject's responses in this section.

Subjects' scores indicate an acceptable level of performance of the three-picture ordering task since only 16% of answers were complete failures. A further 14% of answers also demonstrated some of the subjects' inadequacy since their spontaneous answer was not entirely appropriate. For some subjects, it was a question of responding too quickly to the task since after a second look at their choice they rearranged their series and justified appropriately their sequence, all this on their own. For the other subjects who corrected their first choice, their attention had to be drawn towards the relevant information before they corrected their response.

As far as errors committed by these subjects are concerned, the most common error was a failure to see the continuity between the three represented moments of the sequence. This type of error is manifested in subjects' independent descriptions of each of the three pictures. Since the percentage of this category of error was the highest one, this shows that many subjects still have difficulty in extracting the common context shared by the three pictures of the series. Subjects who committed this type of error could be classified at the bottom of the performance scale, if such a scale was established, since they failed to perceive the essential nature of a sequence, i.e. all moments are connected.



Even though no significant difference was found between scores of the 5 to 6 years old group and the over 6 years old one, the older subjects obtained a higher average score; this fact follows the expected direction.

When scores were matched with classes of transformations paradoxical results emerged from the analysis. Indeed, the analysis revealed that quantitative and position transformations were in certain cases the easiest ones to interpret and in others the most difficult ones to interpret. However, if one accepts the arguments which were put forward to explain these results (in sub-section entitled classes of transformations) one can still suggest that children have less difficulty in interpreting quantitative transformations and that they can be misled by important changes of background, as in set 46-47-48 representing a position transformation. Some evidence concerning the changing background and changes of perspective indicated that when these changes are not "important", i.e. when the relations between objects remain "salient" subjects are not disturbed by such changes. Children's interpretation of 2D information appears to be of the same nature as adult's if the descriptions reported in the preceding part of this chapter are considered as conclusive evidence.

It is very difficult to compare our findings concerning children's competence in interpreting pictures with other evidence recorded in the past on constancies, transformations of stimuli and picture interpretation in general. The reason for this difficulty is the difference in experimental procedure and type of material existing between our study and other investigators' work. Nevertheless, a comparison of Schnall's results concerning classes of



transformations and results obtained in this experiment reveals compatible observations since Schnall (1970) found that size and position transformations were best integrated by subjects. Piaget's work (1956) on spatial acquisitions showed that the topological property of proximity is one of the first properties acquired by children. Findings in this experiment support Piaget's work.

At this point of the study all that can be said with confidence is that children between 5 and 7 years old appear to have a fairly good grasp of the strategies used to interpret static pictures. As a matter of fact, a casual observer would not see the difference between a child's description and an adult's description of pictures. However, children's behavior suggest that they tend to leave out some information since they leave out cues when seriating sequences of pictures. The problem is not a question of "how" to pick up cues (since children's descriptions of pictures demonstrate that they can) but stands more in the actual "picking up of the relevant cues".

### 5.3 A comparison of the two experimental conditions reported in sections 5.1 and 5.2

#### Introduction:

This section of the chapter will be devoted to a comparison of results obtained in the two conditions of the three picture ordering task. Both conditions will be compared according to the average score obtained by subjects and according to the categories of errors produced with the presented stimuli. The comparison will also include data concerning subjects' performances with various

classes of transformations as well as their performances with certain sets of pictures.

When introducing this chapter it was expected that subjects would do better in condition 1 of the three-picture ordering task than in condition 2. The comparison which is about to be reported should confirm this prediction and provide a number of explanations for the differences in performance of subjects to the two conditions.

Before going ahead with this comparison, it is perhaps necessary to reiterate the experimental procedures used in the two conditions. In condition 1, the subject was informed of the position in the sequence of the middle picture of the three-picture set while in condition 2 no such information was given to subjects. Both samples of subjects were presented with the same sets of pictures.

#### Comparison and discussion of results:

##### Scores:

The average score (spontaneously adequate choices) obtained by subjects in condition 1 was 90% while the score obtained by subjects in condition 2 was 70%. As far as complete failures (incorrect choices) are concerned, they amount to 3% in condition 1 and to 16% in condition 2. Subjects who had been informed of the position of the second frame had an obvious advantage over subjects who were not given such information. As predicted, scores obtained with condition 1 were higher than scores obtained with condition 2.

##### Categories of errors:

Definitions were given in sections 5.1 and 5.2 of the categories of errors committed by subjects in the ordering task. The same categories of errors were found in both conditions except



that another category was added to the list for the second condition (5.2), i.e. category 6: excluding pictures from the sequence.

The fact that the child had to process a greater load of information, i.e. envisage a greater number of possible arrangements of pictures, might explain why in certain instances children left some information aside. This behavior might also indicate that children perceived the continuity between only two of the three frames and could not fit one of the represented moments in the sequence. Consequently they would just leave it out of their story. In certain cases, children placed the two most similar pictures of the three picture set side-by-side. Hence, the perceived continuity was limited to pictures sharing more "obviously" the same context. Thus, this behavior restricts picture situations in which continuity between frames can be perceived by children to situations in which frames share an optimum number of features. It can be suggested that children who can only perceive continuity when frames are fairly "similar" (same actors, same relations, same background...) would not perceive continuity if frames were very different.

Both tables displayed in sections 5.1 and 5.2, i.e. Table 5.1.2 and Table 5.2.2 will be reproduced here as the content of Table 5.3.1. The reported percentages stand for the number of inadequate choices which belong to the six categories of errors. The second column represents errors produced in condition 1 and the third column represents errors produced with condition 2. The total number of inadequate choices was 41/399 in condition 1 and 114/380 in condition 2.



Table 5.3.1 Percentage of errors obtained for the six categories of error for condition 1 and condition 2.

Categories	Condition 1	Condition 2
1 Wrong cue	27%	17%
2 Illogical continuity	22%	3%
3 Centration on 1 cue	27%	14%
4 No continuity	10%	31%
5 Cue unused	7%	17.5%
6 Excluding pictures from the sequence		6%

If categories of errors are regrouped in such a way that errors concerned with picking up the relevant cue form a single category (i.e. categories 1,3,5), the percentage of errors in this new category becomes 61% in condition 1 and 48.5% in condition 2. Hence, these figures show that children sometimes fail to pick up the adequate cues and to use them appropriately. Other studies (Vurpillot 1968 and Vurpillot and Brault 1956) have also reported some evidence showing that children tend to leave out some of the available cues in problem-solving situations, either because they do not scan properly the whole display, or because they fail to pick up the relevant cue.

The most interesting result which can be extracted from Table 5.3.1 concerns the number of errors in the "no continuity category". Indeed subjects who have not been informed of the position of the second frame of the three-picture series make many more type 4 errors than the other group. This result suggests that giving the

child a starting point probably helps him to consider the three represented moments as part of a common event. However, another look at Table 5.3.1 shows that subjects who were given a starting point make many more type 2 errors than the other subjects. This might suggest that if subjects are inclined to accept that the three represented moments share a common context this does not necessarily mean that they do see the actual continuity of events since they propose incoherent justifications for their chosen order. It is as if they took for granted that the three pictures were correlated in time but did not bother to look for the proper sequence of events. These children can understand that their stories do not make any sense but they seem at times incapable of changing their first choice as if pictures could not be rearranged. Siegler and Liebert (1974) and Gholson, Levine and Phillips (1973) observed the same attitude of "response perseveration" among 5 and 6 years old. It is as if their final decision was made at the outset of the task and "blinded them to later evidence".

#### Order of difficulty of sets of pictures:

Because of the fairly high scores obtained by subjects in condition 1, an evaluation of the difficulty of certain classes of transformations appeared quite pointless (as was mentioned in section 5.1). Results obtained for condition 2 concerning the same analysis, suggested that quantitative transformations were decoded with ease by children and that position transformations were also readily understood, except in a case (set 46-47-48) where the background of one of the pictures was submitted to an important change.



Since no pertinent conclusions could be drawn in comparing subjects' performance with various classes of transformations as such, a comparison of sets of pictures which obtained very high scores in condition 1 but very poor ones in condition 2, might turn out to be a more fruitful enterprise. Table 5.3.2 lists a number of sets of pictures which obtained very high scores in condition 1 and low scores in condition 2.

Table 5.3.2 Sets which obtained high scores for Condition 1 and low scores for Condition 2.

Sets	Condition 1	Condition 2
22-23-24	90%	40%
46-47-48	100%	45%
31-32-33	100%	60%

Set 22-23-24 Condition 1 subjects appeared to have no difficulty in grasping the context of this set representing a boy eating a chicken. Most subjects saw that the amount of chicken in the boy's plate decreased from the first to the last picture of the set. In condition 2, subjects looked at the series in quite a different way; instead of seeing a decrease in the amount of chicken they concentrated on the boy's attitude. Consequently, their story was about a "boy waiting for his dinner (24), getting it (22) and eating it" (23). It is quite peculiar that such a drastic difference in interpretation was given to the same pictures. Yet, subjects in both conditions agreed that picture 22 preceded picture 23. Since in condition 1 the position of picture 23 was pre-established and since subjects



had decided that picture 22 preceded picture 23 in the sequence, all they had to do to produce the appropriate sequence was to put picture 24 at the end of the row. Condition 1 subjects might have produced the proper interpretation in spite of themselves. Thus condition 1 subjects had a clear advantage on condition 2 subjects. With no starting point many condition 1 subjects might have behaved the way subjects did in condition 2.

Now, this explanation of condition 1 subjects' success compared with condition 2 subjects' performance does not explain why a cue (decrease in amount of chicken) which is so readily used in one condition is only partially used in the other. Could this difference in the child's behavior depend strictly on the difference of procedure? Is it possible to suggest that condition 1 procedure affects the nature of what is picked up by the child?

The present assumption is that depending on the picture which is interpreted first and on how picture 24 is interpreted, children's interpretation of the whole sequence will vary. Condition 1 subjects interpreted picture 23 first as a boy eating a chicken, then they looked at picture 22 and 24. They probably realised that there was more chicken on the plate of picture 22 than on the plate of picture 23 so they concluded that picture 22 must precede picture 23. Now they were left with picture 24 and knew that it could only be placed at the end of the row so they concluded that it must represent the boy who has "finished" eating (no child mentioned that "bones" were left on the plate) if the continuity of the sequence was to be respected. If subjects of condition 2 happened to look at picture 24 first (this picture is often misinterpreted by subjects, many subjects do not actually know what is on the plate) and could not figure out

what was on the boy's plate they probably looked for another cue on which to base their sequence. Suppose that they interpreted picture 24 as a "boy not eating" when they looked at pictures 22 and 23 they saw that picture 23 represents a boy eating; they also noticed that there is more chicken on the boy's plate in picture 22 than in picture 23, so they logically decided that picture 22 should precede picture 23 in the sequence. The evidence produced in chapter 4 (the first picture effect) showed that children tended to place at the beginning of a sequence the picture they interpreted first. In this situation, the subject who started by interpreting picture 24 would choose to place this picture at the beginning of the row. Since the chosen order is 24-22-23, the only coherent story the child can make up will have to be centred on the actor's action instead of on the amount of chicken on his plate. One of the decisive factors which influences children's stories in this case appears to be the interpretation of picture 24. If children interpret this picture as a boy in front of a plate full of bones they probably produce the sequence 22-23-24. If they cannot figure out what is represented on the boy's plate, they switch to another cue and make up a different story. The other decisive factor of the position of picture 24 in the sequence is when it is interpreted. If it is interpreted first, greater are the chances of it being placed at the beginning of the sequence. However, if children do see bones in picture 24 they might be inclined to place picture 24 at the end of the sequence. This whole discussion suggests the importance of the interpretation of the first picture and how this interpretation can affect the child's perception of the whole context of the sequence.

Set 46-47-48: The reason why only 45% of subjects produced a proper



answer in condition 2 has been discussed in section 5.2. It seemed that the change of background in picture 48 broke the continuity of the sequence so that subjects did not know where to fit it in the sequence. The condition 1 child was once again sure of the position of picture 47 and it appeared logical to place picture 46 at the beginning of the series since Rupert was further up in the tree in picture 47 than in picture 46 (subjects had described picture 47 as Rupert climbing up a tree before they had been presented with the two other pictures). It seems that because the child of condition 1 was asked to interpret picture 47 at the outset of the task, he already had some basis on which to interpret the whole series of pictures or at least to figure out the position of picture 46 relative to picture 47. Once the child had decided that picture 46 preceded picture 47 all he had to do was to place picture 48 at the end of the row. In condition 2, many subjects did not seem to have a clue of how to link these three pictures. Some of them disposed pictures 46 and 47 one beside the other (9/11) but were very undecided about the position of picture 48 in the sequence. In general it was very difficult to perceive any continuity in these subjects' stories.

Set 31-32-33: This set appeared particularly easy to order by subjects tested in condition 1. However, the same spontaneous behavior was not representative of the second condition sample. In condition 1, all subjects were interested by the distance cue while in condition 2 some subjects were attracted by other cues; others left one picture out of the series while others were unable to correlate at all the three represented moments. It is difficult to find a sure explanation for the difference of scores between the two



conditions. However, it might help to know that many subjects of condition 2 corrected their answers after being questioned, which means that with a little help they could see the proper continuity of the 3 illustrated moments. The problem does not seem to be related to the particular class of transformation (distance) represented in this set (since when questioned subjects used this class of transformation) but rather to the subjects' incomplete and too quick response. Evidence collected in chapter 4 showed that a set of pictures representing a change of distance was treated as the less ambiguous set by subjects. This piece of evidence reinforces the belief that subjects do not have any particular difficulty in coping with changes of distance on the contrary they are usually quick in picking up this cue.

#### Conclusion:

What transpires from this discussion is that informing subjects on the position of the middle picture of a three-picture series is a precious help to young subjects. The effect of this information was manifold: it helped subjects to consider the two remaining pictures in the light of their first interpretation and to direct their attention on the proper cue. It also reduced the number of possible arrangements of pictures in such a way that once the position of one of the two remaining pictures had been decided, the position of the third one was also determined.

In the next section of this chapter, the child will also be given a starting point from which to interpret the sequence of events. However, since the number of pictures will be increased, the ensuing consequence of the increase in possible arrangements of pictures should restrict the impact of the starting point.

#### 5.4 Ordering sets of four and five pictures

The position of the first or last picture of the sequence is designated to the child.

##### Introduction:

As for the three preceding sections of this chapter, the purpose of the experiment reported here is to find out still more about subjects' difficulty in picture ordering tasks. An analysis of errors produced by subjects in this experiment should bring still more light on the effect of changing backgrounds in sets of pictures, on children's ability to pick up the relevant cues distinguishing "similar" pictures, on their ability to follow simultaneous interactions in sets of pictures and on the effect of pointing out the position of a picture on the child's grasping of the context of the sequence of events. As explained in the conclusion of the preceding section, the increase in number of pictures presented in this experiment will counteract the benefit produced by informing the child on the position of one of the pictures. Consequently, it is not expected that this piece of information should be as helpful as it was shown to be in condition 1 (section 5.3).

##### Material:

Four sets of pictures were presented to subjects. Two sets of pictures contained four pictures and two sets contained five pictures. These pictures were taken from Rupert the Bear Annuals (Daily Express Annuals 1972-1973 publications; they are presented on the following two pages).





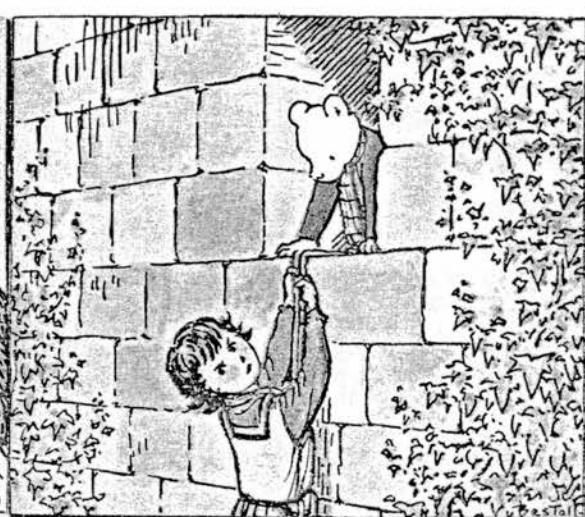
1



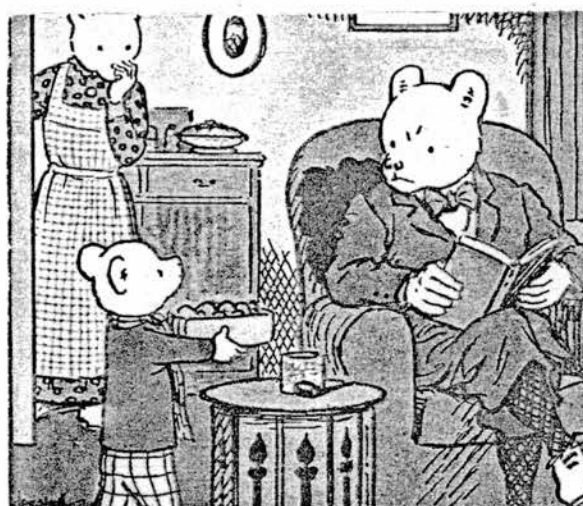
5



2



6



3



7

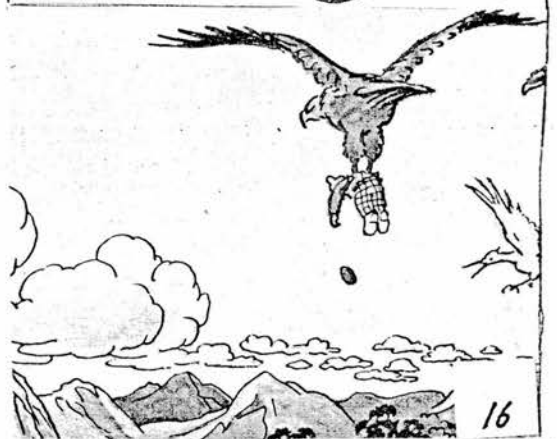
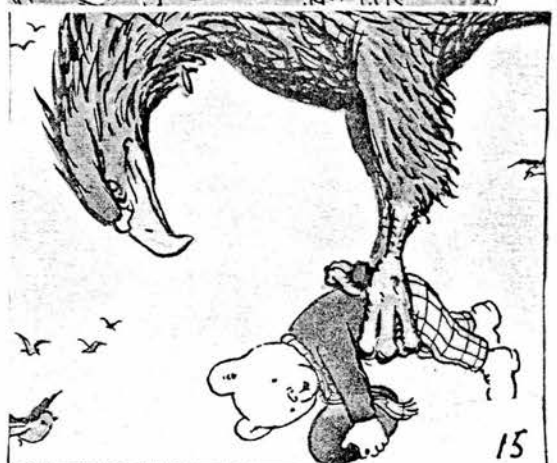
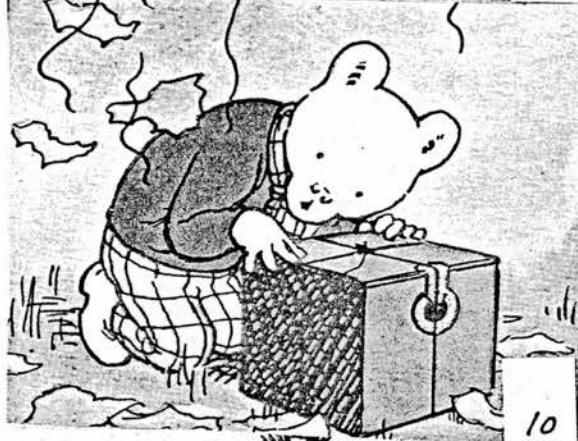


4



8





Subjects:

Twenty subjects participated to this experiment. All these subjects had been tested before with experiments reported in chapter 4 and chapter 5. The average age of the sample was 5;10 with the youngest subject being 5;1 and the oldest being 7;1.

Procedure:

The position of one of the pictures in each one of the sets was pointed out to the child after he had been given the instructions. In three cases, the first picture of the sequence was pointed out to the child and in one case the last picture was designated. The reason for designating these particular pictures lies in their informative content (the picture which appeared to be of better use for the subject).

Subjects were first presented with the two sets of four pictures and then with the two sets of five pictures. Subjects were reminded of past tests and told that they would be asked to perform more or less the same task with a greater number of pictures. They were also told that the position of one of the pictures would be pointed out to them in order to help them make up the story.

Instructions:

"I will show you pictures telling four little stories. In some stories there will be four pictures and in other stories five pictures. I would like you to try and find the story the way you did before with the other pictures and to make a row with the pictures the way your story goes. The picture telling the beginning of the story goes on this side of the table (left) and the next one goes just beside and the next one beside and the last one goes on that side of the table (right). To help you I will tell you which picture tells the beginning of the story (or the end of the story)."



After one of the pictures of the series had been pointed out, the remaining pictures were presented in random order. After the child had ordered a set of pictures he was asked to justify his choice and to tell his story.

### Results:

A twofold analysis of subjects' answers was carried out. The derived results are displayed in Table 5.4.1 and in Table 5.4.2. In Table 5.4.1 subjects' responses were divided in three categories (as in section 5.1 and 5.2): spontaneously adequate choices (Sp.A.C.), corrected choices (C.C.) and inadequate choices (I.C.). These responses were then classified according to the sets of pictures from which they were issued.

Table 5.4.1 Distribution of the three categories of responses obtained for the four sets of pictures. (N=20).

Sets of pictures	Sp.A.C.	C.C.	I.C.
1-2-3-4	12/20	6/20	2/20
5-6-7-8	7/20	5/20	8/20
9-10-11-12-13	15/20	3/20	2/20
14-15-16-17-18	11/20	2/20	7/20

To produce Table 5.4.2, subjects' errors were classified according to categories of errors defined in section 5.1 and 5.2 of this chapter. These categories are: category 1 - wrong cue; category 2 - illogical continuity; category 3 - centration on one cue;



category 4 - no continuity; category 5 - cue unused; category 6 - excluding pictures from a sequence.

Table 5.4.2 Percentage of errors obtained for the six categories of errors.

Categories of errors	Percentage of spontaneously inadequate choices
2 Illogical continuity	29%
4 No continuity	11%
5 Cue unused	31%
6 Excluding pictures from a sequence	29%

The average score obtained with these four sets of pictures is 56%. If corrections were accepted the score goes up to 76%. Since scores between sets vary in a noticeable but still not outstanding way and since categories of errors vary greatly with each set, it appears more profitable to analyse sets of pictures individually rather than as a group.

Analysis and discussion of each individual set:

Set 1-2-3-4 Subjects usually made up very consistent stories after they had ordered this set of pictures. However, picture 2 was often left aside or misplaced. When the child was asked to make sure that his row of pictures corresponded to his story, in most cases the proper adjustment was made. In two cases, pictures 3 and 4 were interchanged but this inversion was easily corrected as the child examined his sequence for the second time. Subjects were quick to

see the continuity of this sequence of events, their errors were elicited more by their lack of attention and their rashness in giving an answer than in their ability to extract the context from the interrupted sequence of events.

Set 5-6-7-8 This set of pictures appeared particularly difficult for subjects. The purpose of the characters' actions portrayed in this series was far from being clear for many subjects. Many of them tried to link a few pictures based on some common feature but when the time came to make up a story, the succession of events made no sense. An example of an illogical reasoning is the story of a child who described the series as follows: "They were climbing up to get down".. Since children appeared to have such little grasp of the situation, they were asked to consider picture 5 once again and to say "where the actors were and what they wanted to do". After answering adequately to these questions five subjects reorganised their series appropriately and made up a coherent story. This behavior suggests once again that an accurate interpretation of the first picture of a sequence helps the child to perceive the context of a sequence and to organise the portrayed events into a coherent whole. In this case "verbalising" one's interpretation of the first picture seemed to help subjects plan their sequence. As Lashley (1951) says on the problem of serial order, "the context or the knowledge of intention of the actor determines the sequence".

Nevertheless, this verbalisation did not help all subjects in their seriation task. A number of subjects still could not make out that picture 6 preceded picture 7 even if they had accepted that Rupert and his friend were coming down from the castle. It seems that for a number of subjects the reasoning involved in deciding on



the sequence of the moments was too complex a task. All these subjects seemed to have retained was that the actors were coming down from the castle window and they did not see as necessary the fact that Rupert's friend had to have come down first from the castle window in order to justify his presence on the ground in picture 7. This attitude suggests that when subjects have to combine a certain number of facts in order to decide on the sequence of events, it becomes more difficult than to deal with a single straightforward action.

Set 9-10-11-12-13 Subjects quickly grasped the context of this set of pictures. Most children made up a coherent story but some of them left one of the pictures out of their story. After being asked to retell their story while pointing to the corresponding pictures most subjects were able to readjust their sequence. The high score obtained for this set of pictures suggests that children can follow with relative ease a straightforward action (i.e. when the sequence of events is irreversible) performed by a single actor, in a more or less constant background.

Set 14-15-16-17-18 This set of pictures was quite difficult to seriate for many subjects. For some subjects, the problem lay in grasping the context of the sequence and for others, in using distinctive cues in pictures 15-16 and 17-18. For instance, the latter would interchange pictures 15 and 16 and pictures 17 and 18 because they had missed the distinguishing cue.

Once again, the changing background in this sequence might have hindered subjects' chances of detecting the continuity of the action. Many subjects must have realised that some pictures had a certain affinity since they paired pictures 15-16 and pictures 17-18.



However, the absence of knowledge of the context of this sequence prevented them from finding the appropriate order of these pictures. There was no age difference between subjects who succeeded or failed in this task.

Conclusion:

What bore out of the analysis of subjects' responses was that categories of errors varied from one set to the other. One of the factors responsible for this variation seems to be subjects' grasping or not grasping the context in which the represented events took place. Indeed, set 5-6-7-8 and set 14-15-16-17-18 were the most difficult sets to interpret and they account for most of the category 2 and category 4 errors. For sets 1-2-3-4 and set 9-10-11-12-13, subjects produced good stories and the reason for most mistakes was children's inattention, since they readjusted their series on a second appraisal.

The difficulty of the task does not necessarily weigh on the number of pictures presented (if results to four-picture sets are compared with results of five-picture sets).

Even though subjects were informed of the position of one of the pictures, this information was not sufficient to provide the whole context of the sequence, although in set 5-6-7-8 the verbalised interpretation of the first represented moment helped some subjects to coherently seriate the four pictures.

What emerges from this experiment is that extracting the context from sets of pictures, using the relevant cues to distinguish between frames as well as perceiving the irreversibility of a certain order of events in time, are all important factors in picture

ordering tasks. Another important variable to take into account is that subjects find it more difficult to cope with sets of pictures featuring simultaneous interactions (as in set 5-6-7-8 where subjects were asked to reason on simultaneous interactions). Piaget observed that at the stage of intuitive thought "l'enfant a de la difficulté a raisonner sur deux relations a la fois" (Piaget, 1947, p. 141).

## CHAPTER 6

The role of context in picture ordering tasks

The evidence recorded in the last two chapters on children's reactions to picture ordering tasks will serve as a basis upon which further hypotheses will now be tested.

The analysis of subjects' responses revealed that in many cases children did not grasp the context underlying a succession of represented events. Children's reactions to two sets of pictures analysed in section 5.4 (sets 5-6-7-8 and 14-15-16-17-18) were an all or nothing reaction in respect to the comprehension of the context, i.e. subjects either grasped or not the context of these series. If subjects did not grasp the context, it was almost impossible for them to propose any logical continuity to the series. Subjects coupled similar pictures (as in set 14-15-16-17-18) or excluded a picture from the sequence (e.g. often subjects would place it at the end of the row of pictures) or else they ordered pictures fairly arbitrarily. Finding the general context of a sequence of events seems to be the primary step to complete before any more specific analysis is conducted on a set of pictures.

However, it also emerged from subjects' behavior with sets 1-2-3-4 and 9-10-11-12-13 (section 5.4) that even though subjects could grasp the context of a sequence it did not necessarily follow that they produced the proper sequence. Subjects interchanged pictures or left one out of the series on their first trial probably because they did not scan attentively all the pictures (a second look at their first choice usually incited subjects to reconsider their first sequence.



A number of other factors which seemed to affect subjects' interpretation of sets of pictures were also derived from the analysis of subjects' responses reported in chapter 5. These influential factors were either the child's interpretation of the first attended picture, his difficulty in following simultaneous interactions between objects or the "size of the difference" between frames.<sup>5</sup>

One way of finding out more about the factors mentioned above is to neutralise the effect of context on picture ordering tasks. This can be done either by providing the child with the contextual information, i.e. a story describing the succession of events or by presenting him with picture situations which are known to be understood by children ("easy contexts"), due to past experiments.

Four experimental conditions were designed to evaluate the role of context on subjects' performance and to appraise more directly the effect of the previously enumerated variables. In one condition, (section 6.1) the subject was presented with "easy context" picture-situations (these sets represent transformations which are known to be understood by children).

In the next condition (section 6.2), subjects were presented with two series of five pictures representing simultaneous interactions between several objects and containing pairs of pictures between which differences are minimised (evidence has already been collected in section 5.4 showing that subjects have problems in dealing with simultaneous interactions between objects, e.g. set 5-6-7-8). In this

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<sup>5</sup> Similar frames were more easily interchanged (e.g. in section 5.4 set 14-15-16-17-18) and pictures sharing too little likeness with the rest of the series were either left out of the sequence (e.g. in section 5.2 set 46-47-48) or artificially included in the sequence without any coherent justification to explain their position.

experiment the child will be asked to make up a story with each group of five pictures (phase a ). If his story is not adequate or pictures are inappropriately ordered, he will be told a story and asked to match his sequence with the order of succession of events in the story (phase b ). By comparing these subjects' performance in both phases, one should see if providing the child with a story or the contextual information is a sufficient requirement for picture ordering tasks. Past evidence leads us to believe that grasping the context underlying a sequence of events is not a guarantee of success in picture ordering tasks.

In the third condition (section 6.3), instead of a narrated story, an animated story (a film cartoon) was presented to subjects. The reason for this variation is to find out if the modality of presentation of the context affects subjects' performance. Paivio's hypothesis (1968) suggests that a certain interference can be elicited if the stimulus material (story) and the task material (pictures) are represented in two different modalities. The problem lies in the child having to use information presented in two different modes: visual and verbal.

Following these three experimental conditions, a fourth experiment (section 6.4) was carried out to show that if the context is provided children can order series of pictures composed of well differentiated frames in an acceptable way. The comparison of results obtained in section 6.2 and section 6.4 should demonstrate that children have less difficulty in ordering sequences of pictures composed of well differentiated frames than sequences of pictures composed of pictures sharing numerous common features given the context of course.

## 6.1 Children's tendency to overlook details in "easy context" picture situations

### Introduction and material

It is easier to explain what is expected from this experiment if the material to be used is described along with the purpose of the task. The role of context has been stressed as an important factor in a picture ordering task. It was suggested that presenting subjects with "easy context" situations would facilitate children's task of organising series of pictures into a coherent whole.

The material chosen for the experiment to be reported in this section (four sets of coloured line-drawings), was selected according to children's success with preceding sets. Sets 1-2-3-4-5 and 17-18-19-20-21-22 share a similar context with two sets presented in chapter 5: set 16-17-18 previously presented in section 5.1 and set 9-10-11-12-13 previously presented in section 5.4. Set 1-2-3-4-5 represents a woman hanging clothes on a clothes line and the other set (17-18-19-20-21-22) portrays Rupert opening up a parcel containing a Jack in the box.

Moreover the analysis conducted in section 5.2 revealed that quantitative transformations were a generally easy class of transformation for children (with known restrictions of course). The two other sets of pictures were therefore conceived with these results in mind. Set 6-7-8-9-10 represents Rupert making clay men, i.e. in this set the formation of a clay man is witnessed piece by piece. Set 11-12-13-14-15-16 represents Rupert making a jigsaw puzzle; each frame represents an extra piece of puzzle compared to the preceding frame.

These "easy context" sets of pictures were used in order to demonstrate that even though the child has a good grasp of the context



represented in a series of pictures, it does not necessarily follow that he will produce the adequate sequence. In order to obtain tangible evidence for this hypothesis, the approach chosen was to minimise the perceptual difference between certain frames; consequently, the subject would need to study closely each individual frame in order to perceive the differences. A look at the four sets of pictures will exemplify what is meant by "minimising differences" between frames. In set 1-2-3-4-5, the critical difference is between picture 2 and 3 (the usual increase from one picture to the other is represented by the addition of an extra piece of clothing on the line while the critical difference here is in the number of clothes-pegs on the second piece of clothing).

In set 6-7-8-9-10 the difference between each frame is minimal; furthermore, pictures 6 and 10 could be ambiguous if the subject does not perceive that there are two complete clay men in picture 10 and only one in picture 6.

In set 11-12-13-14-15-16 each frame represents an increase of one piece of puzzle on the preceding frame. However, each piece of puzzle contains an uneven percentage of new information. For instance, the first piece represents a tree, the second piece a house, the third piece a sun, the fourth one some grass, the fifth one a path and the sixth piece another section of the path. If the subjects construct the puzzle merely on the basis of what new elements appear from one frame to the other instead of on the number of pieces, it is possible that some of them will overlook the difference between frames 13 and 14 and between frames 15 and 16 since frames 14 and 16 do not represent important additions to the global picture.

The last set (17-18-19-20-21-22) shows Rupert in the process of opening a box. This set of pictures could be divided in three pairs of pictures on the basis of similarities between frames. The pair which is expected to be the most critical is represented by pictures 19 and 20. In order to decide that picture 19 precedes picture 20 the subject should notice that the letter which was sitting on top of the box in picture 19 is no longer there in picture 20 and 21. Given that pictures 21 and 22 should logically be placed side-by-side, it follows that picture 19 should precede picture 20.

The surprised expression on Rupert's face in picture 22 suggests that the sequence of events starts with picture 17 and not picture 22. (All these pictures are presented in the following three pages.)

#### Subjects:

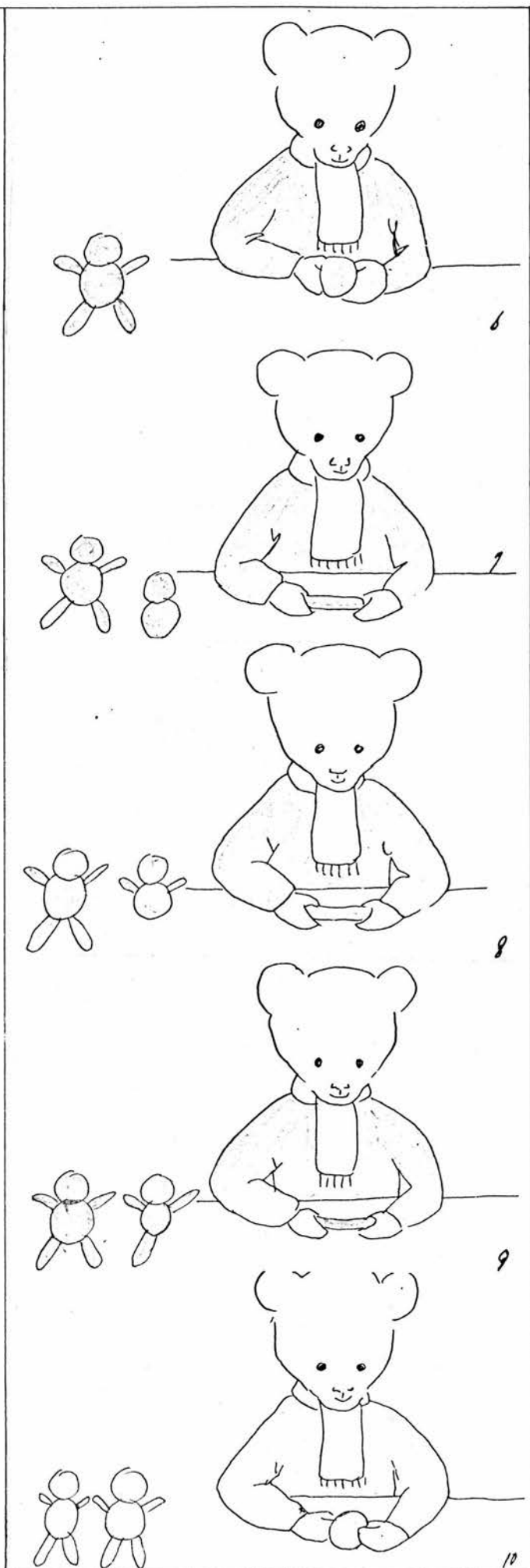
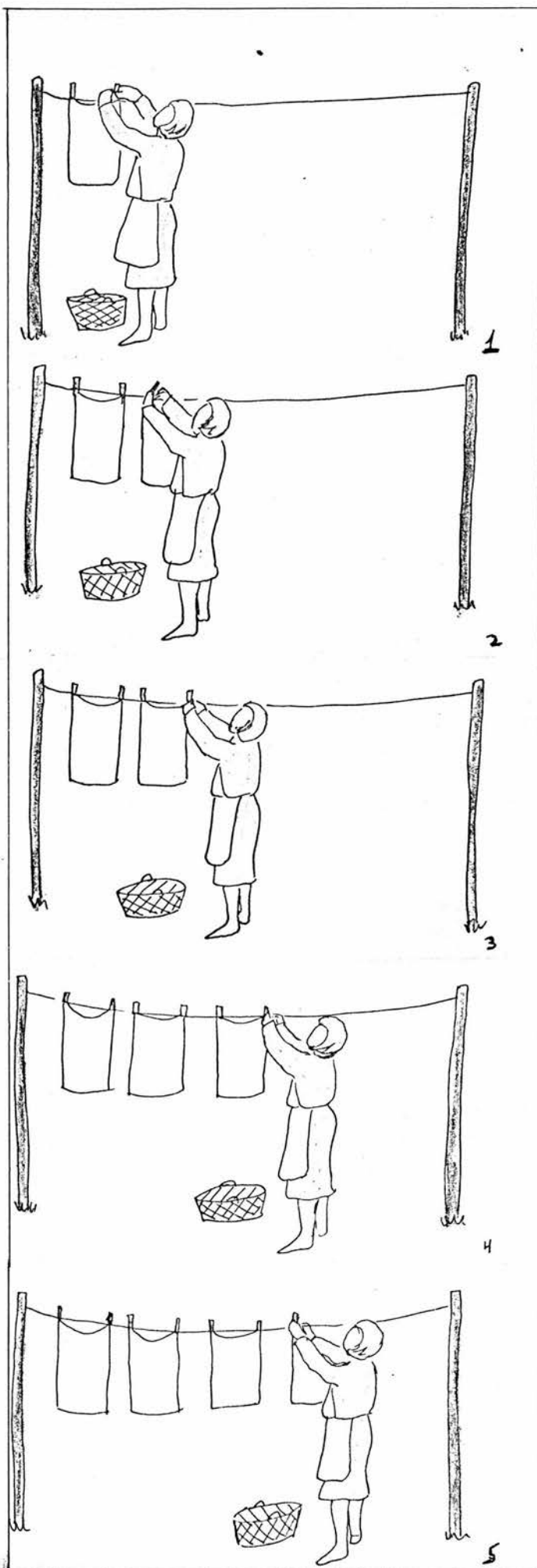
Twenty subjects were used in this experiment; they had been tested with the experiment reported in section 5.2 (seriation of three pictures). Their average age was 5;9.

#### Procedure:

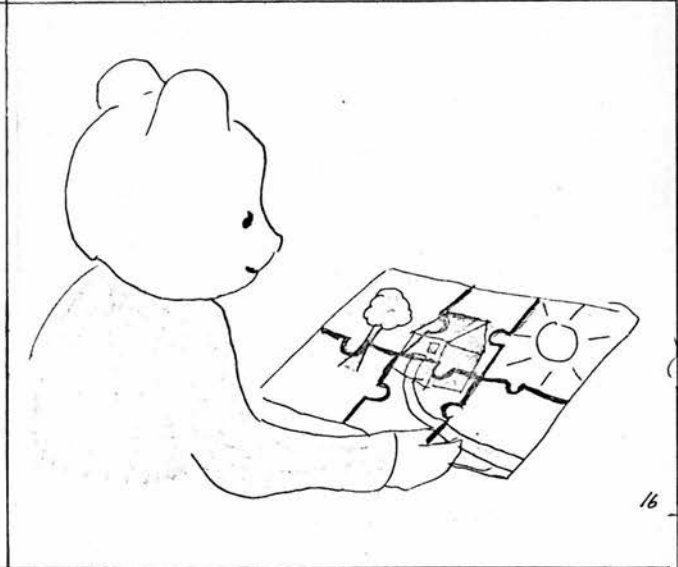
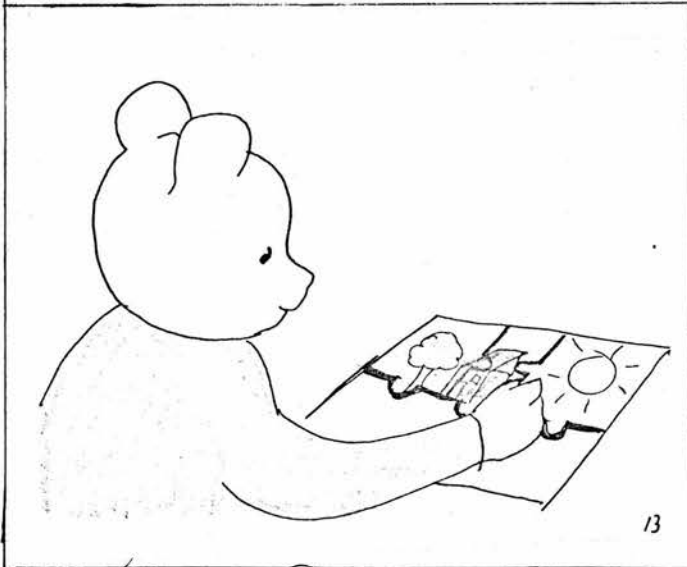
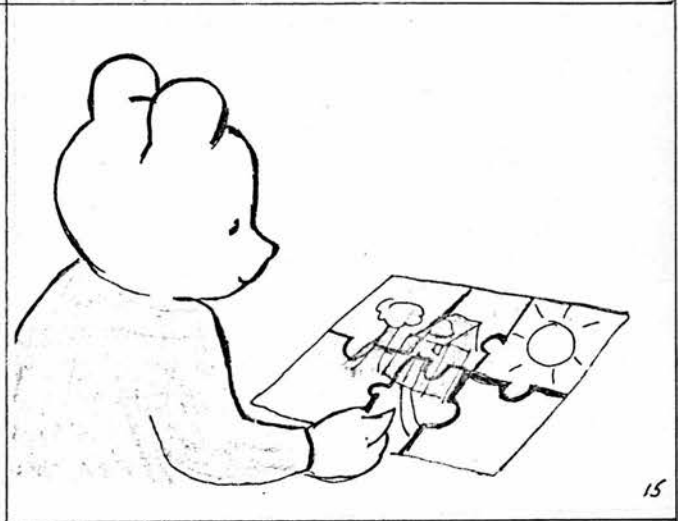
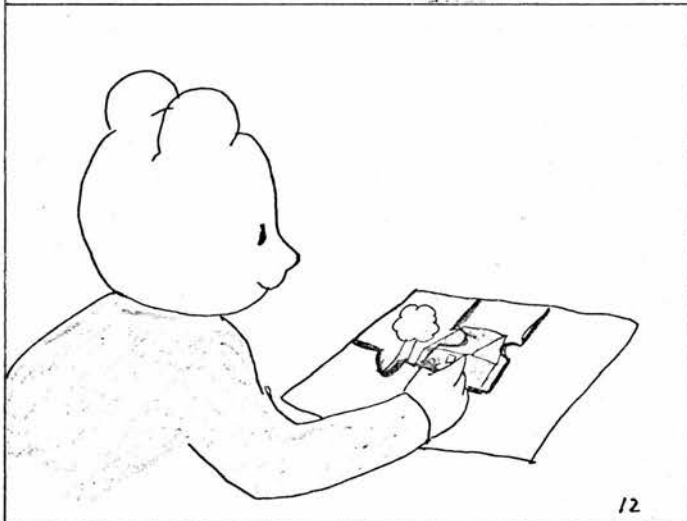
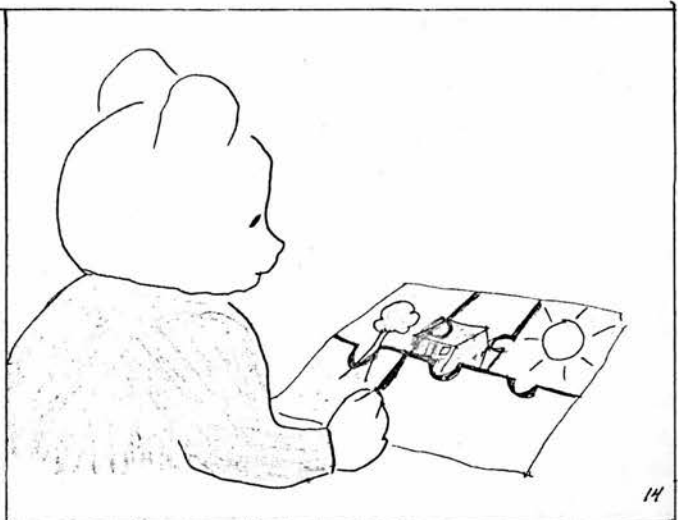
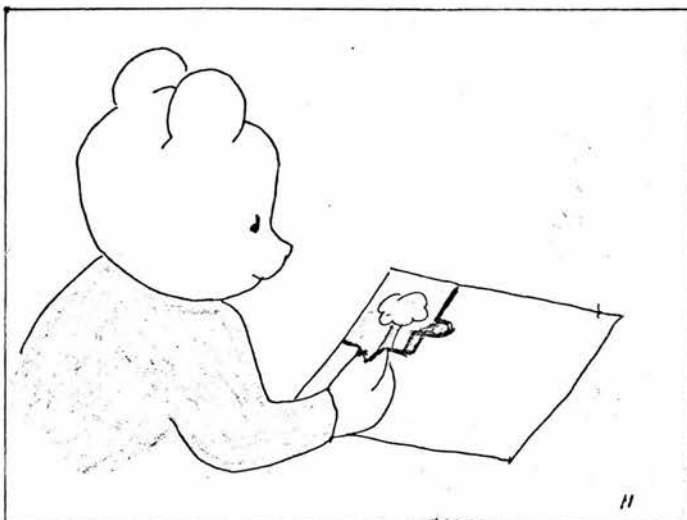
Subjects were presented with the four sets of pictures in the numerical order with which they are labelled above. Pictures were presented in random order and subjects were allowed a first look only after they had all been displayed. Subjects were reminded of the previous session (section 5.2) and told they would be asked to make up stories with an increased number of pictures.

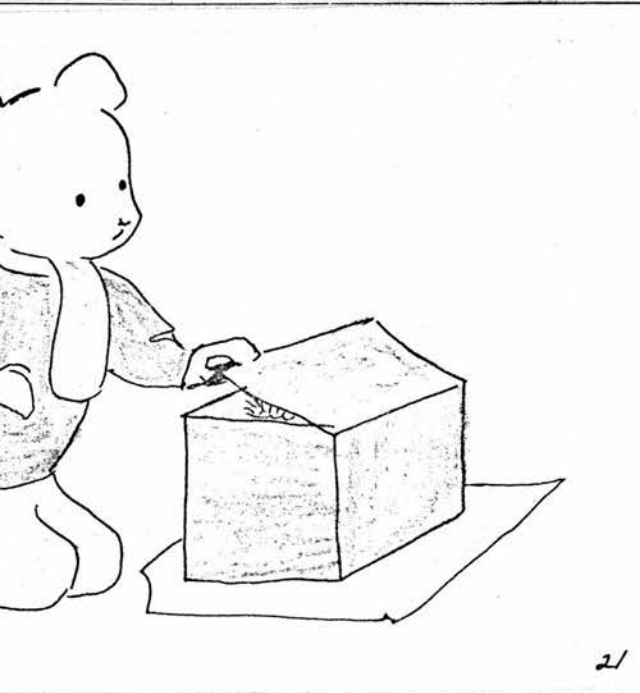
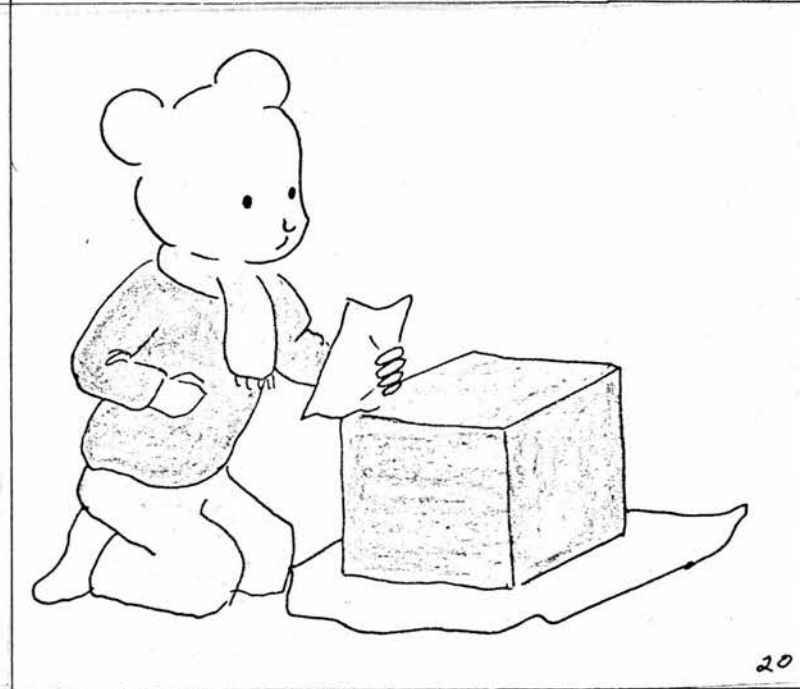
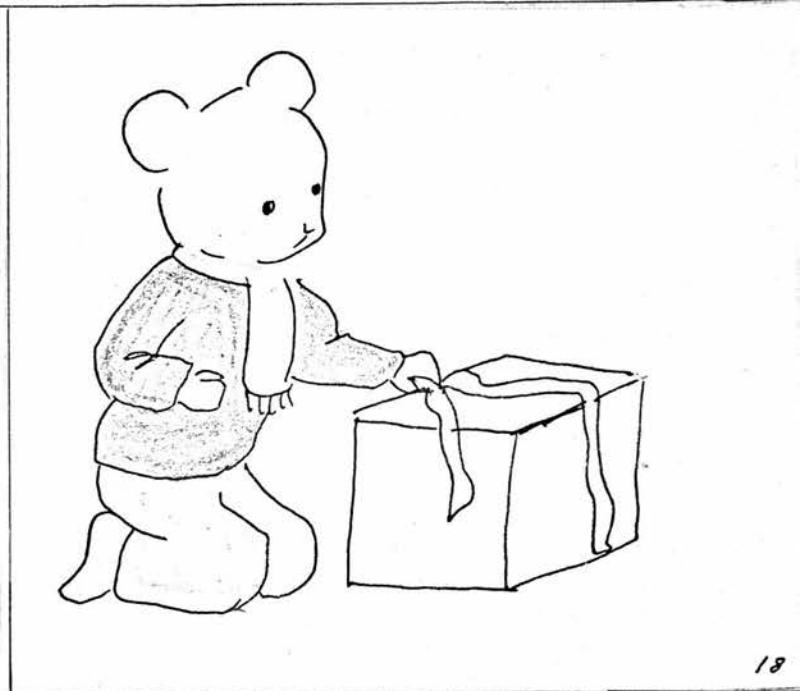
#### Instructions:

"I will show you some pictures telling four little stories. In some stories there will be five pictures and in other stories four pictures. I would like you to try and find the story the way you did before with the









other pictures and make a row with the pictures the way your story goes. The picture telling the beginning of the story goes on this side of the table (left) and the next one goes just beside it, the next one beside ..... and the last one goes on that side of the table (right)."

After the child had terminated his sequence he was asked to make up the corresponding story pointing at the pictures as he went along.

### Results:

In the majority of cases subjects quickly grasped the context of these series of pictures before they tried to order them. Reflections such as, "This is easy!", "I know this one!" were familiar comments at the end of the session. Wide grins and grabbing at the pictures were also familiar scenes. (Young subjects would look at me after completing their sequence with an expectant look as if to say: "Look, see how well I did, it is right isn't it?")

Results displayed in Table 6.1.1 reflect children's unthinking attitude in producing a sequence.

Table 6.1.1      Percentage of success obtained with the four sets of pictures.

Sets	Scores
1-2-3-4-5 (hanging clothes)	50%
6-7-8-9-10 (clay men)	40%
11-12-13-14-15-16 (puzzle)	65%
17-18-19-20-21-22 (parcel)	70%



Each set will be analysed individually in order to point out the particular behavior elicited by each one of them.

Set 1-2-3-4-5: Half the subjects misplaced pictures 2 or 3 (except for one subject who interchanged pictures 4 and 5). Some subjects would keep one of the two pictures in their hand wondering where to place it in the series, other undecided subjects would place it at the end of the row, and some of them would make a second row placing picture 2 (or 3) under picture 3 (or 2). Other subjects would simply place picture 3 in front of picture 2 in the sequence. Most subjects who had produced the proper sequence could justify their chosen order (one subject produced the proper sequence but could not justify her choice, she even interchanged pictures 2 and 3 in the wrong order when asked to justify her sequence). When the child's attention was directed towards the number of clothes-pegs in the second and third frame he usually produced the adequate sequence. Subjects who produced inadequate sequences were 5;7 as an average.

Set 6-7-8-9-10: Subjects quickly grasped the idea conveyed in this set: "Oh! he's making little men" was a typical comment produced as children glanced at the set of pictures. Six children did not perceive the difference between pictures 6 and 10 (the difference between these two frames is in the number of completed clay men) and the remaining mistakes consisted in interchanging two or more pictures. It took the child much longer to produce the adequate sequence here than it had taken him with set 1-2-3-4-5. The obvious reason is that the minimal differences between each frame required sharper attention from subjects. The average age of subjects who did not produce the appropriate sequences was 5;8.

Set 11-12-13-14-15-16: When this set of pictures was described earlier it was mentioned that the child could use the changing pattern or the number of pictures as the cue for the sequence. Four subjects who relied on the changing pattern of the puzzle produced wrong sequences. Two other subjects simply misplaced two pictures because they did not count puzzle pieces attentively and another one responded in such an unthinking way that he mixed up many pictures. When subjects were asked to reconsider their choice (are you sure pictures go this way?) or simply when came the time for them to justify their order, five of them produced an adequate sequence. Children counted the number of puzzle pieces more often than they used the puzzle's pattern to justify their choice. This counting strategy proved safer and quicker than the other one. The average age of subjects who made mistakes was 5;4.

Set 17-18-19-20-21-22: Since this set obtained a relatively acceptable score (70%), it seems that children can follow a straightforward action fairly well. Three subjects behaved as predicted, i.e. they interchanged pictures 19 and 20. However, the three of them corrected their sequence when came the time to justify it. Two subjects grouped pictures 17-18-19 and pictures 20-21-22 out-of-order and could not justify their choice coherently. One subject described the series in the reverse order and would not envisage any other order even if he was asked to reconsider the series as representing Rupert opening up a present. The average age of subjects who made errors was 5;7.

### Discussion:

In the introductory part of this section a few predictions were made on the nature of errors which would be committed by subjects.

Findings supported these predictions for sets 1-2-3-4-5 and 6-7-8-9-10, i.e. subjects misplaced pictures 2 and 3 in set 1-2-3-4-5 and interchanged pictures 6 and 10 in set 6-7-8-9-10. Regarding set 11-12-13-14-15-16 more children used the counting strategy than the naming strategy to figure out the construction of the puzzle, i.e. children ordered the series of pictures on the basis of the increases in the number of puzzle pieces rather than on the nature of the added elements. This strategy appears to be less risky than the naming strategy because of the uneven level of novelty of individual puzzle pieces (if the child looks only for new elements, he will be inclined to overlook pictures which represent only extensions of what already caught his eye).

In regards to set 17-18-19-20-21-22, only a few subjects, three, confused the critical pair of pictures (19-20); however, they were able to readjust their sequence when came the time to justify it. Responses obtained to these sets of pictures demonstrate subjects' carelessness and negligence rather than their incapacity to perceive minimal differences between frames since most of them realise their errors if they spend enough time scrutinising the display. However, strictly speaking, a child on his own would certainly overlook minimal differences between pictures since he proceeds in such a hasty way on his first trial. On the basis of the evidence gathered here one must admit that even though a child can grasp the context underlying the logical structure of series of pictures, he tends to overlook what was labelled minimal differences between frames.

The rapidity with which the child grasped the context in these sets of pictures suggests that the number of pictures used in this



experiment (sets of five and six frames compared to four and five frames in section 5.4) was not an impediment to the actual understanding of the picture situations. However, longer series of pictures require more attention and since children are known to have a limited span of attention, it seems logical to assume that longer series of pictures would provide more occasions for mistakes in a seriation task.

Concerning the age of subjects who produced incorrect sequences, their average age is 5;7, a little under the average age of the whole sample (5;8). The four subjects who made no mistakes at all had an average age of 6;2. Once again it seems that older subjects tend to make less errors than the younger ones but it is not an uncommon event to see a younger subject do better than an older one (see appendix 2).

The use of sets 1-2-3-4-5, 6-7-8-9-10, 11-12-13-14-15-16 representing quantitative transformations allows us to draw a parallel between the classical seriation problems and the picture ordering task used here.

Piaget (1970) claimed that preoperational children only succeed by trial and error in seriating rods of different lengths, that it is only when the child has reached the operational level that he will search systematically for the biggest or smallest rod as he goes along building his series. In this experiment, the child's criteria for judgement was not height as in the seriation of rods task but other quantitative criteria (e.g. more clothes on the line, more parts on the clay man, more pieces in the puzzle). These children were not instructed to seriate pictures in the increasing or decreasing order as

subjects are in the classical seriation task (staircase). They simply used their knowledge of the situation to decide on the direction of the series (increase or decrease). They proceeded by searching for the picture representing the smallest number of elements, then the next biggest and so on until all pictures had been seriated. In most cases subjects knew very well how to proceed to produce the adequate seriation even though they misplaced some pictures. They knew that the number of elements represented in each frame was the cue to look for. It therefore seems that, in this experimental condition the child can co-ordinate ordination and cardination, i.e. he can decide on the ordinal position of a picture in the series given information about the various cardinal values, something Piaget claimed the preoperational child could not do. To substantiate this statement Piaget had used subjects' responses to a task which consisted in establishing a correspondance between two groups of objects of increasing sizes.

Lloyd (1974) found that it was much easier for young children to "pile up" blocks of different sizes than to seriate rods. He could, however, only give tentative explanations of this difference. One explanation of this difference was that piling up objects is a much more familiar task for young children than lining them up. Another explanation would be that the only way in which one can pile up blocks is to start by the biggest one otherwise the whole structure risks falling down. The child might have learned this hard fact of life after many attempts or from older companions. In the condition reported in this section, the ease with which subjects grasped the direction of the series might depend on the familiarity of the behavior portrayed

in each set and on its inherent logic. For instance the child's spontaneous grasp of the order of series 1-2-3-4-5 might depend on the child's familiarity with the action of hanging clothes and on his being conscious of the fact that when one hangs clothes the progression goes from one piece of clothing to "more". The child can understand that the succession of pictures develops in a particular order (one piece of clothing, two clothes ... ) because he has seen it before, but when he is asked to seriate a series of rods in an increasing order, this order is arbitrary in a sense since it does not appeal to a concrete familiar and meaningful experience. The familiarity of certain seriating conditions might explain the relative facility of some of them compared to others.

In the picture ordering task, the child's activity involved counting discrete units from one frame to the other. In the classical seriation task it involves comparing relative lengths of sticks. The difference between these two procedures might explain why subjects were quicker at grasping the picture ordering task than they are said to be with the classical seriation task (Piaget, 1952).

However, Lloyds' (1974) findings concerning children's ability to pile up blocks in decreasing sizes indicate that the child's problem (in the classical seriation task) is not solely one of dealing with "continuous material" instead of "discrete units" since he does well with the "piling-up blocks" situation. This evidence suggests once again that the child's familiarity with certain situations might be of great value to him in several types of seriation tasks.



## 6.2 Children's difficulty to follow simultaneous interactions between elements and minimised differences between pictures (two conditions)

### Introduction and material:

In the previous experiment, presented sets were chosen as a function of the simplicity of the underlying context. The child's ability in differentiating between similar frames (differences between frames were minimised) were studied. Results demonstrated that even though the child had a fairly good grasp of the context underlying the structure of the series of pictures, he tended to overlook minimal differences between frames and consequently produced partially inadequate sequences.

The experiment to be reported here was designed on the basis of this evidence and on observations gathered in section 5.4 (i.e. subjects seemed to have more difficulty in following simultaneous interactions between elements of pictures than to follow straightforward actions performed by a single actor).

The two sets of pictures to be presented in this experiment were therefore chosen to exploit these exposed difficulties. The following description of these two sets of pictures illustrates how the potential difficulties were expressed in pictures and what types of response these obstacles are expected to elicit.

Preceding this description, a word should be said about the procedure. The experiment is split into two phases (phase a and phase b ). In phase a the child is simply asked to produce a story (a sequence) with the pictures; if his sequence is inadequate, in phase b he is told a story from which he is asked to produce the corresponding sequence.

The purpose of this split procedure is to study the effect of the story (i.e. the contextual information on the child's performance). In the previous experiment results demonstrated that the knowledge of the context underlying a sequence of represented events is an insufficient condition to produce adequate sequences.

The purpose of the whole experiment is twofold; it expects firstly to find evidence of young subjects' difficulty in distinguishing between similar pictures as well as their difficulty in following simultaneous interactions between elements. The second aim is to demonstrate the insufficiency of providing subjects with a model (story) under circumstances described above.

The two sets of pictures which are about to be described are labelled "Freddy" and "Ronny"; these are the names of the main characters in each one of the stories.

Freddy, the story:

"Freddy got a beautiful red ball for his birthday. One day Freddy went outside to play with his new red ball. He bounced it and kicked it and once, it went so high that it fell on the roof of his house. Freddy was very sad; he thought: 'I have lost my beautiful red ball and the roof is too high for me to go and get it'.

Freddy's daddy had been watching him from the window and when he found out what had happened, he took a ladder, went up on the roof and got Freddy's ball. Freddy was very happy and went on playing with his beautiful red ball."

This set is composed of five coloured drawings and the scenes represented in all five pictures are set in the same background. The relations between elements portrayed in this set are as follows:

Picture 1: Freddy is playing with a ball in front of his house.

Freddy's father is standing in the window.

Picture 2: Freddy is standing in front of the house.

The ball is on the roof.

Freddy's father is standing in the window.

Picture 3: Freddy is standing in front of the house.

The ball is on the roof.

Freddy's father is standing in the doorway.

Picture 4: Freddy is standing in front of the house.

The ball is on the roof.

The ladder rests against the wall.

Freddy's father is up the ladder touching the ball.

Picture 5: Freddy is in front of the house.

The ball is in Freddy's father's hands.

The ladder rests against the wall of the house.

Freddy's father is in front of the ladder.

In order to produce a coherent sequence, the subject has to follow the relations between Freddy and the ball, the relations between Freddy's father and the house (window, door, ladder), the relations between the ball, Freddy, the roof and Freddy's father as well as the relation between Freddy's father, the ladder and the ball. As one can notice, many of the relations between the represented objects take place simultaneously. The subject is asked to notice which ones remain stable from one frame to the other and which ones vary. If the subject centres on one relation and neglects another critical one, chances are



that he might interchange pictures. For instance, the child might notice that the relation between Freddy and the ball has changed between pictures 1 and 2 and 1 and 3. However, if he does not notice that the relation between Freddy's father and the window remains the same in pictures 1 and 2 but changes in picture 3, he might place picture 3 beside picture 1 centring on the difference between Freddy and the ball, but leaving aside the difference in relation between Freddy's father and the house (i.e. his relation with the window and the doorway).

Another interchange of pictures might take place between pictures 4 and 5 if the subject overlooks the change in relationship between the ball, the roof, Freddy's father, and the ladder. The reason why the expression "interchanges of pictures" is used rather than simply "misplacing of pictures" is that children tend to group similar frames together. Since the first three pictures share numerous common features as well as pictures 4 and 5, it is expected that they will be grouped and that subjects' omissions of differences and similarities will be expressed in interchanges of pictures within each group.

Since the subject will have to follow simultaneous interactions between elements (changing and unchanging relations) he will need to explore each picture thoroughly. It has already been observed that young subjects tend to proceed rather hastily when ordering series of pictures and it is expected that many of them will behave in the way described above with pictures 2 and 3 and pictures 4 and 5.

Ronny, the story:

"Ronny got a beautiful little boat with a red sail for his birthday. One day Ronny took his red boat to a pond nearby to have it sail near the shore. He held the boat by a string so it wouldn't go too far out.

Ronny was having a very good time with his boat until the wind caught the red sail and blew it further out on the pond. Ronny tried to bring it back in but the string broke and the red boat sailed away from the shore.

Ronny started crying when he saw his boat go further out on the pond. A man nearby heard Ronny cry and when he saw what had happened, he jumped in the water and brought Ronny's red boat back; Ronny was very happy then, and took back his beautiful red boat."

This set is composed of five coloured line-drawings and the scenes represented in the five pictures are set in the same background.

The relations between the elements portrayed are as follows:

Picture 1: Ronny is pulling his boat along the shore.

A string links Ronny to the boat.

Picture 2: Ronny is walking along the shore holding the string.

The string is detached from the boat.

Picture 3: Ronny faces the pond crying.

The boat is further away from the shore and Ronny.

Picture 4: Ronny faces the pond, he is not crying.

A man, his trouser-legs up, is touching the boat.

Picture 5: Ronny faces the man, holding out his arms.

The man, with his trouser-legs up, is holding the boat.

With this set of pictures, a subject has to follow the relations between Ronny, the boat (the string) and the shore, the relation between the boat, the shore and the man and the relation between Ronny, the boat and the man in order to produce an adequate sequence. Since the man appears only in two frames, the number of relationships in three of the five pictures are inferior to the number of relationships in "Freddy's story". In this set the critical relationship to follow in order to differentiate pictures 1 and 2 is the relation between Ronny and the boat (string). The critical difference between 1, 2 and 3 is Ronny's attitude (crying, and facing the pond) and the position of the boat. The critical differences between pictures 4 and 5 are the relative positions of Ronny, the man and the boat.

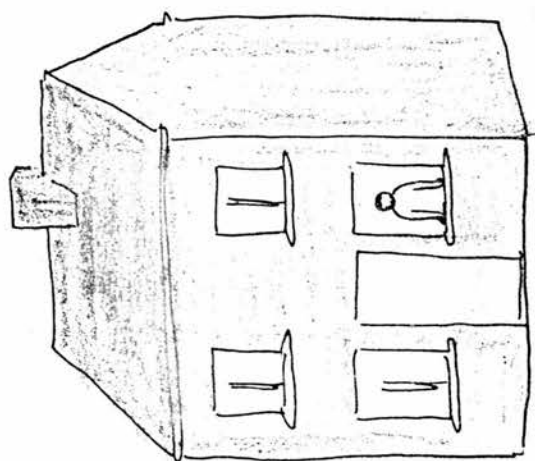
On the basis of subjects' reactions to other sets of pictures, it is expected that pictures 1-2-3 and pictures 4 and 5 will be kept together since they share common features. The interchange of pictures 1 and 2 is also expected because of their similarity.

"Freddy" is expected to be a more difficult seriation task than "Ronny" because to figure out the order of the first three pictures in Freddy, one has to switch back and forth, from one picture to the other comparing the position of the ball and of Freddy's father. With Ronny, a look at the relation between the boy and the boat is a sufficient cue to deduce the order of the first three represented moments.

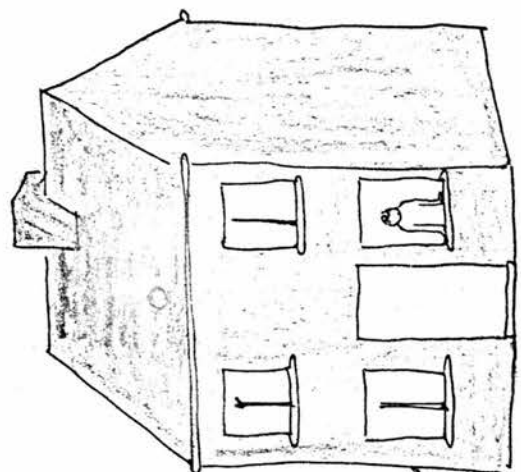
#### Subjects:

The same 20 subjects used in the experiment reported in section 6.1 were tested with these two sets of pictures. Their average age was 5;9.

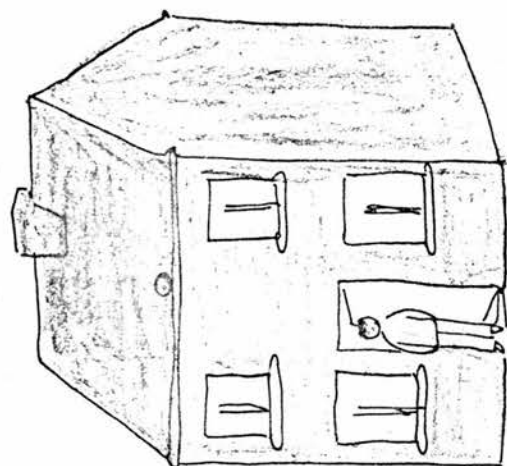




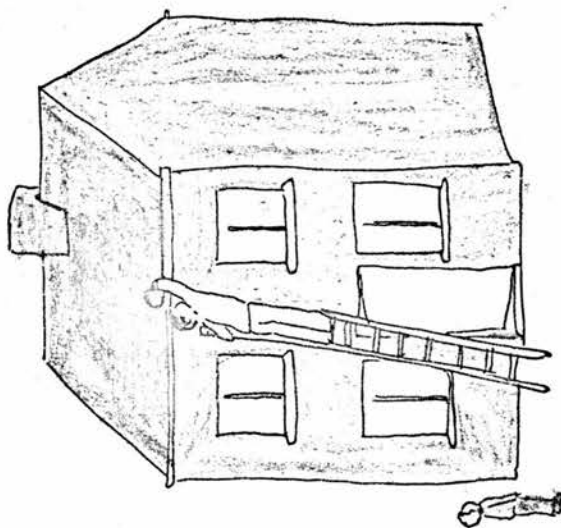
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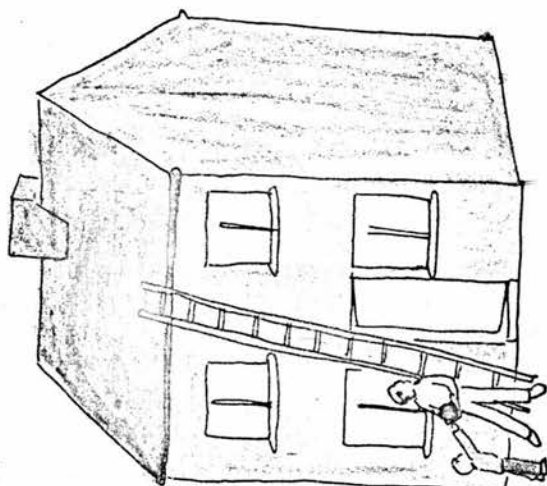
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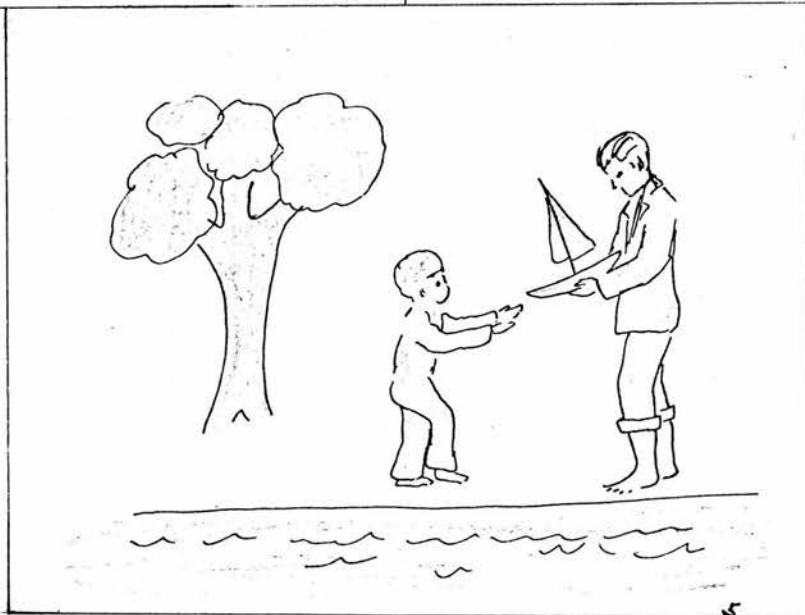
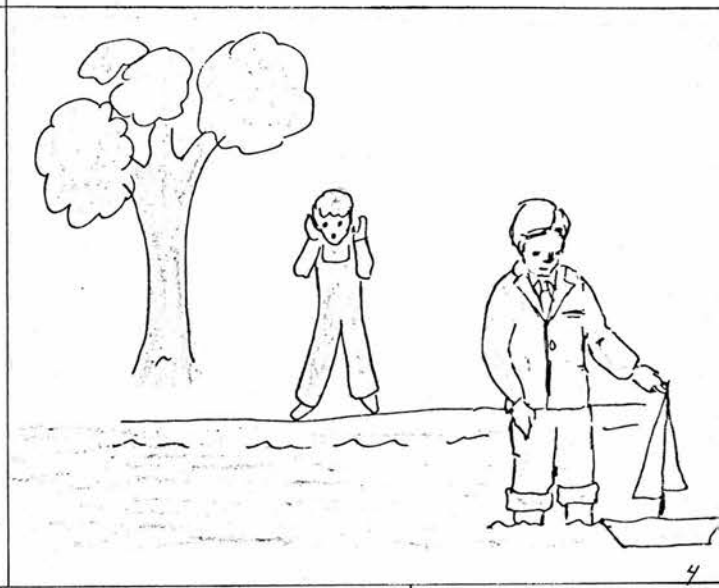
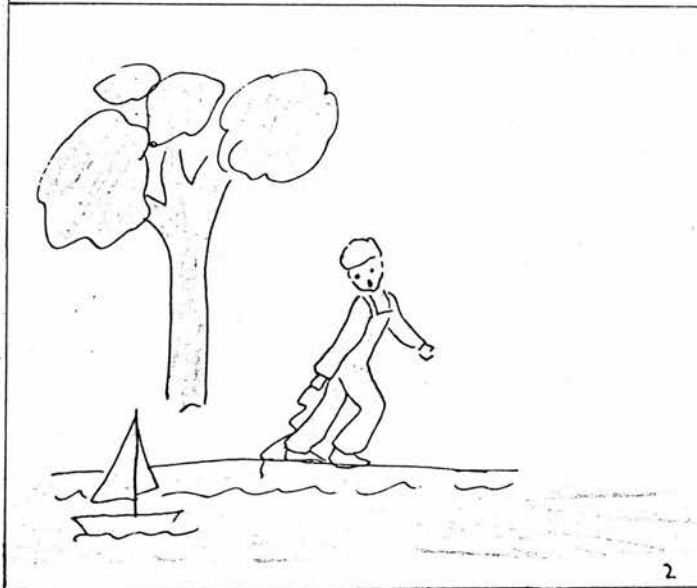
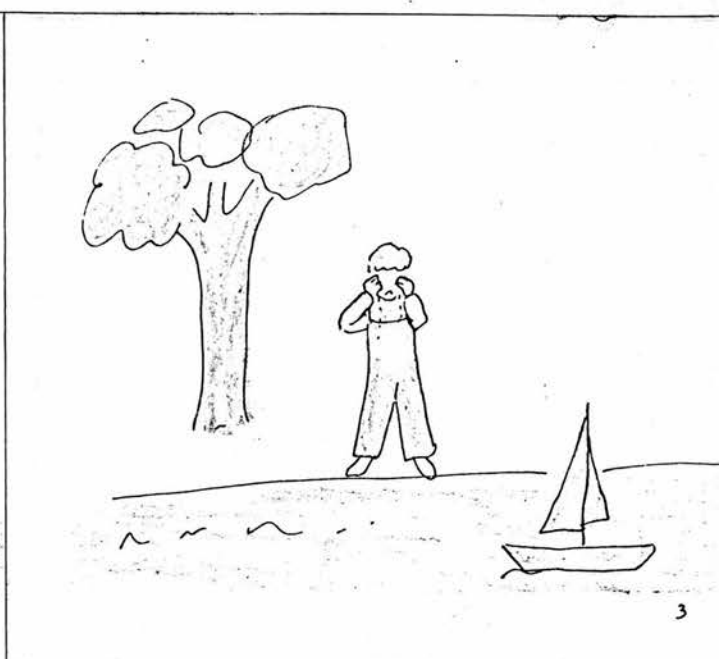
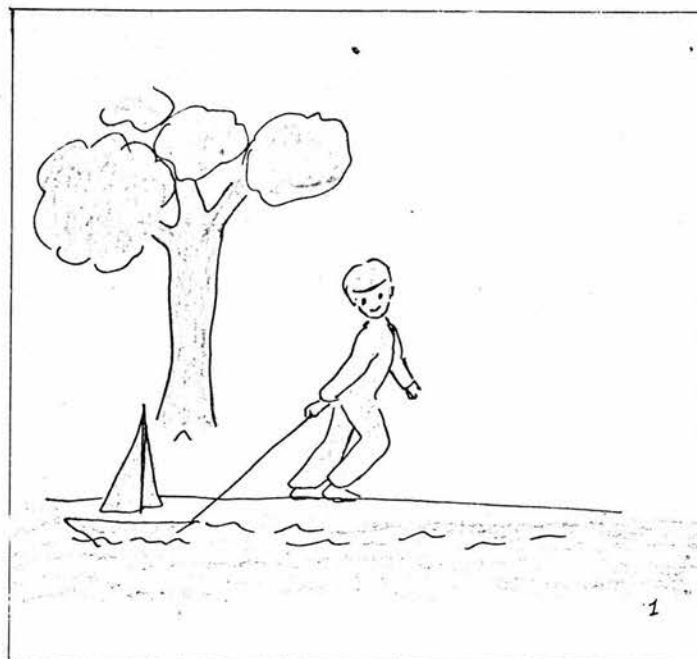
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4



5



### Procedure:

Subjects were presented with Freddy and Ronny in this order. The five pictures of each set were displayed in front of subjects in random order. Subjects were told that once again they would make up stories and order pictures according to the way events unwound in their story.

### Instructions:

Phase a : "I will show you pictures telling two little stories. In each story there are five pictures. I would like you to try and find the story the way you did before with the other pictures. You put the picture telling the beginning of the story on this side of the table (left) and the one telling the end of the story on that side of the table (right)."

After the child had lined up all the pictures he was asked to tell his story. If the child's sequence was inadequate phase b followed.

Phase b : After making up his story the child was told: "I also know a story that goes with these pictures, would you like to hear it? I will tell you my story and you try and see if you can put the pictures in a line the way "my" story goes. So listen carefully to my story if you want to know how to put the pictures."

The child was asked to justify his sequence by telling the story he had been told and pointing at the corresponding pictures.

### Results and discussion:

Table 6.2.1      Average score (%) obtained for Freddy and Ronny in phase a and phase b of the experiment.

	a	b
Freddy	40%	60%
Ronny	55%	75%



**Table 6.2.2** Categories of errors produced with Freddy and Ronny in phase a of the experiment (figures in bracket refer to the number of the pictures interchanged).

Categories of errors	Freddy	Ronny
Interchange of pictures	(2 and 3): 3 (4 and 5): 5 ] 62%	(1 and 2): 2 22%
Excluding pictures from the sequence	3 23%	5 56%
Illogical continuity	2 15%	1 11%
No continuity		1 11%

**Table 6.2.3** Categories of errors corrected in phase b of the experiment. (Figures in brackets refer to the number of the pictures interchanged.)

Categories of errors corrected	Freddy	Ronny
Interchange of pictures	(2 and 3): 1 (4 and 5): 4	(1 and 2): 1
Excluding pictures from the sequence		3

Results displayed in Table 6.2.1 for phase a indicate subjects' difficulty to produce adequate sequences of events with both sets of pictures (Freddy: 40%, Ronny: 55%). A look at Table 6.2.2 provides us with the categories of errors produced with the two sets. The most common type of mistake produced with Freddy is the interchange of pictures (8/13 cases or 62%); this category of error had been predicted on the grounds that subjects tended to overlook differences between similar pictures and that they would have difficulty in following simultaneous interactions between elements. Five subjects displayed some difficulty in producing a coherent sequence with "all" five pictures. Three subjects managed to make up a story using only some of the pictures while two other subjects failed completely in this task.

With Ronny, the major problem as shown in Table 6.2.2 seemed to be to make up a coherent story with "all" the pictures and for two subjects to interpret this sequence as a logical sequence. It therefore appears that with Ronny, subjects' main problem was to discover the structure underlying the "whole" sequence of events.

It has been noticed that subjects who excluded some of the pictures from their stories (in Ronny) excluded either picture 1 or picture 2 from their sequence. (Subjects usually placed the unused picture at the end of their row or simply left it out of their story.) Let us assume that pictures which are discarded from a series probably have little informative value for the child. Since either picture 1 or picture 2 was discarded, this suggests that one of these two pictures had little informative value for the child. If these two pictures have been treated as redundant information, it implies that the child did not use the differentiating cues of pictures 1 and 2. It then becomes

possible to assume that excluding one or two similar frames from a sequence is another way for children to express nondifferentiation of similar pictures.

The fact that pictures 1 and 2 were not placed adjacently is rather uncommon procedure for children. In past experiments, it has been noticed time and again that children group similar pictures. Even though the previously noted examples demonstrate that similar pictures were separated, other subjects did group similar pictures. Indeed, out of the nine subjects who produced inadequate sequences with "Ronny" six of them kept pictures 1-2-3 in adjacent positions and five of them kept pictures 4 and 5 in contiguity. As far as Freddy is concerned, seven out of the 12 subjects who produced inappropriate answers, juxtaposed pictures 1-2-3 while 11 subjects juxtaposed pictures 4 and 5.

Another look at Table 6.2.1 shows a certain improvement in subjects' performance from phase a to phase b. This difference surely demonstrates the value of providing a model or the context underlying a sequence of represented events to subjects. However the positive effect of such a model is not complete since subjects still commit errors. A look at Table 6.2.3 shows the categories of errors which were corrected after subjects had heard the stories in phase b of the experiment.

For Freddy, subjects corrected their first sequence by placing in their proper order, pictures which had been interchanged. This correction was made four times with pictures 4 and 5. A plausible explanation for this type of correction seems to be that hearing the story forced subjects to concentrate on the specific cues identifying pictures 4 and 5 and to match events with pictures instead of simply



grouping pictures on the basis of their similarity. As far as Ronny is concerned, providing subjects with the corresponding story helped several subjects who only used a few pictures to make up their story in phase a of the experiment, in finding an appropriate position in the sequence for each one of the frames. It also helped a subject to reorganise pictures 1 and 2 in their proper order.

Another glance at Table 6.2.3 shows that subjects who had not succeeded in perceiving the coherent continuity of the sequence (N=4) were not helped by hearing the story since they were not the ones who corrected their original choice. One can suppose that the narration of events helped subjects who already knew the story by increasing their attention to distinctive features of pictures. Perhaps giving subjects a second opportunity to review their sequence is all they need to extract the relevant cues.

#### Conclusion:

As predicted, subjects interchanged pictures sharing the greatest number of common features (in Freddy 8/13 cases). However, many children had a still more basic problem to solve since some of them could not figure out the general organisation of the sequence of events or construct a structure in which each frame occupied a position in time.

If categories of errors are classified on a qualitative scale of performance, it seems that "no continuity" errors are more primitive types of errors than "undifferentiation" errors, i.e. a child who has no grasp at all of the structure underlying a sequence of events is at a clear disadvantage relative to a child who already has a grasp of

the portrayed situation and whose final task is to differentiate between similar frames.

With regard to this question of differentiation, subjects' overt behavior of excluding one of two similar frames from their sequence was interpreted earlier as the covert reaction of someone who did not recognise the difference between similar frames and who treated them as portraying redundant information. In other words, excluding pictures from a sequence is another manifestation of undifferentiation.

To sum up the situation it seems that one of the child's difficulty in this experimental situation was to decipher the underlying context in these sets of pictures. The other main difficulty was to deal with similar pictures portraying simultaneous interactions between elements.

The aim of phase b of the experiment (which consisted in producing a sequence of pictures matching a story) was to appreciate the role of context on a picture ordering task. Data expressed in Table 6.2.1 showed an increase in the number of subjects who produced an appropriate sequence once they had heard the story. However, since scores were not perfect (60% and 75%) this suggests that grasping the underlying context represented in a series of pictures is not the sole ingredient necessary to produce coherent temporal serialiations. In fact something which was somewhat surprising was that providing subjects with a story did not help those who did not already have a certain grasp of the context represented in these pictures. Subjects who had produced illogical sequences or had not perceived any continuity in phase a of the experiment did not show any improvement in phase b. Their average age was 5;7 which is below the average age of the whole group which was 5;9.

Relating performance and age leads us to suggest that very young subjects might not be able to benefit from a story since they do not use it. Yet, this incapacity might be linked to the nature of the particular stimuli used in this experiment.

The fact that subjects who corrected their first choice already had a certain grasp of the context was discussed earlier on. It was suggested that what pushed subjects to correct their sequence was the opportunity of reviewing their sequence and finding the critical cues. Providing subjects with a story might therefore have a double effect: 1 - providing the contextual structure of a sequence, 2 - encouraging subjects to attend to the previously unattended cues.

Although predictions according to the types of corrections made by subjects in phase b of the experiment did not obtain all the support expected, (interchange type errors were to remain in phase b ), another experiment will demonstrate that children can cope better with series of pictures in which pictures are "well differentiated" than with series of pictures in which some frames share a great number of common features and in which simultaneous interactions take place.



### 6.3 Picture seriation task using a film-cartoon as a model

It has just been argued that even though the child is provided with the context underlying the temporal progression of a series of portrayed events, this supplementary information is only a partial solution to the child's problem of seriating events in time.

Providing a model for the picture seriation task did not appear to be a totally satisfying solution. The reason was subjects' tendency to overlook detailed differences between frames and their difficulty in following simultaneous interactions between several elements.

Paivio's analysis of children's behavior in a paired-associate-learning task (P.A.I.) led him to some interesting suggestions as to the effect of the modality of encoding and decoding material on the child's success in P.A.I. tasks. Paivio (1968) believed that the child has a problem when he is asked to give a response in a different mode than the stimulus mode. For example, a child who is asked to pair a word with a picture and then asked to respond verbally by naming the picture, will have to change his modality of coding from visual to verbal. This change impairs the performance by creating an interference since the child has to "translate" his representation of the learned material from visual to verbal.

In the experiment reported in section 6.2 (phase b), subjects were told a story and asked to use this verbal information as a model for the picture seriation task. If Paivio's hypothesis is correct, the child might have found it difficult to use the verbal information provided since he was then asked to recover it in pictures, i.e. in visual information. In order to verify the existence of this possible

interference, another experimental situation was set up. Instead of providing the child with a "verbal" model, a film was projected from which a series of static frames had been selected as seriation material. The aim of this experiment is to show that the child's difficulty in ordering a series of pictures does not depend on the modality of presentation of the context but on his inadequate strategies in picking up the relevant cues. Consequently, Paivio's hypothesis should not find any confirmation in this experiment.

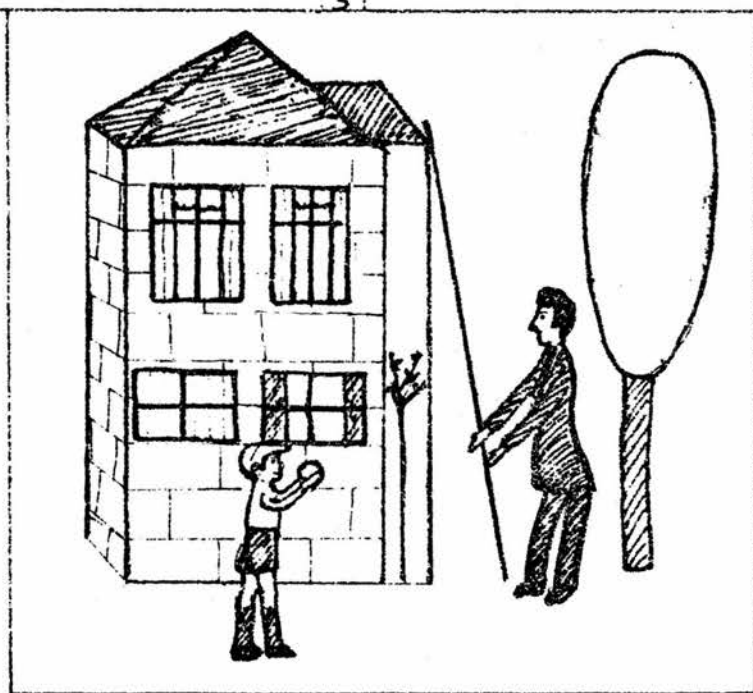
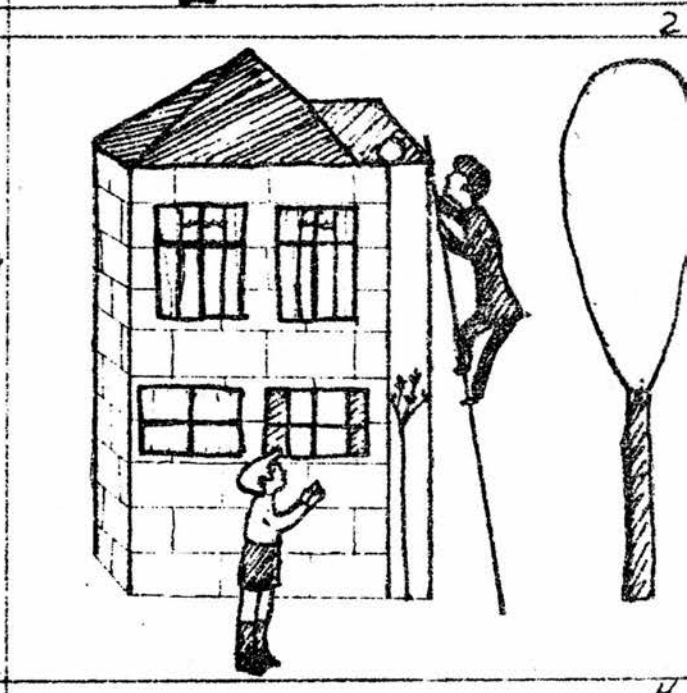
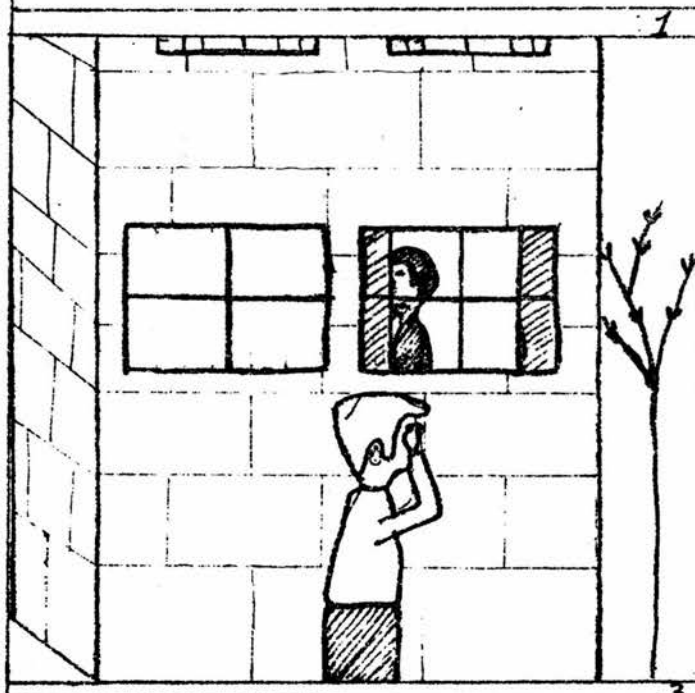
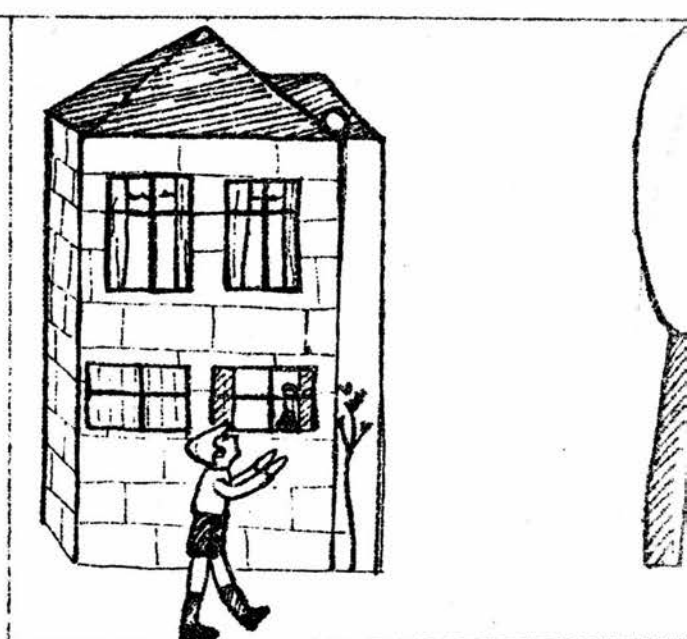
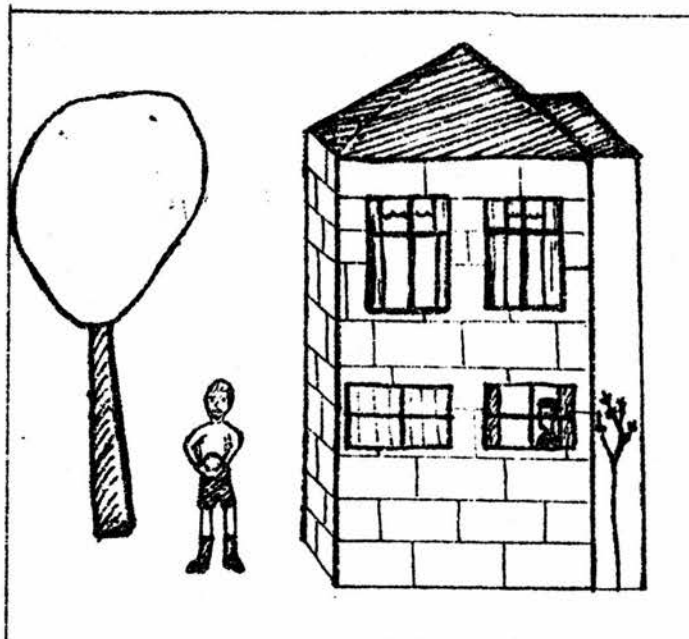
On the basis of results obtained in section 6.2 (phase b ) it is expected that subjects will produce more or less the same categories of errors since differences between frames will be of the same nature as the ones expressed in the previously presented Freddy.

#### Subjects:

Twenty-seven subjects attending Primary 1 classes in an Edinburgh school were presented with the film cartoon. These subjects had been tested with pilot studies reported in the first part of this dissertation. Their average age was 5;9 years (between 5 and 5;11).

#### Material:

The film cartoon presented in this experiment was a visualisation of Freddy's story in section 6.2 (phase b ). The super 8mm coloured film lasted just over a minute. Five pictures were extracted from the film; they represent the five main events of story (they appear on the following page).





### Procedure:

The film cartoon was presented to the subjects. After subjects had narrated the events taking place in the film they were asked to order pictures in their order of appearance in the film. They were then asked to justify the order of their sequence. Each subject was seen individually and his answers recorded with pencil and paper.

### Instructions:

"I will show you a film; it's about a little boy called Freddy. I would like you to look at it carefully because I will ask you to tell me the story."

Once the film had been projected and the child had told his story, he was instructed as follows:

"I have five pictures here, they have been taken from the film. They tell Freddy's story. I would like you to tell me which picture shows what happened first in the story, what picture shows what happened next, and next ... and what happened last. You put the picture telling the beginning of the story on this side of the table (left), the one that comes next beside it and the one that tells the end of the story on that side of the table."

Once the child had produced his sequence he was asked to justify it: "why do you think the pictures go like this? can you tell me the story? which picture says that?" Some subjects had to be reminded of the seriation procedure. Some subjects would point out to the pictures in the right order but this order was not always the way in which pictures had been lined up.

### Results:

All subjects were able to tell the story which had been projected on the screen; some subjects gave more details than others

in their description of the film. Regarding the picture ordering task, 14/27 subjects (52%) produced the adequate sequence. Table 6.3.1 displays the categories of errors committed by subjects in the picture ordering task.

Table 6.3.1 Percentage of errors obtained in the two categories of errors (figures in brackets refer to the number of the pictures interchanged).

Categories of errors	Percentage of error			
Excluding pictures from the sequence	(7/13)	54%		
Interchange of pictures	(2 and 3)	(2/13)	15%	] 46%
	(4 and 5)	(4/13)	31%	

Subjects who left a picture(s) out of their series usually discarded pictures 2 or 3; in two cases, picture 4 was also excluded from the sequence. These subjects would tell their story pointing at three or four pictures (which were ordered in the correct sequence), but they would neglect to mention the picture(s) stuck at the end of the row. When they were asked to describe the event pictured in this last frame and asked if it represented the last event of the story, most subjects would realise that their choice was not adequate. Some subjects managed to integrate the discarded picture in its appropriate position in the sequence but others behaved as if the row of pictures could only contain four pictures, e.g. if a subject decided that picture 2 came after picture 1, in order to place it in this position

picture 3 was removed and placed at the end of the row. Consequently, the whole process had to be resumed.

### Discussion:

An interesting point arises when results of section 6.2 (phase b) are compared with results obtained in this experiment. First of all, if both average scores are compared (60% in section 6.2 and 52% in section 6.3) it appears obvious that presenting subjects with a film instead of a verbal model, does not improve subjects' picture ordering performance as one could have expected according to Paivio's hypothesis. It seems that the child's main problem is still to pick up the relevant cues to produce the appropriate sequence since no improvement was noticed when both the stimulus and the response material were presented in the same modality.

In regards to the categories of errors produced with the "narrated Freddy" and the "animated Freddy", an appreciable number of interchanges of similar frames took place in both conditions (62% for the narrated Freddy and 46% for the animated Freddy). Furthermore, if the explanation given in section 6.2 on why subjects discarded picture(s) in "Ronny" is accepted, one finds that it applies here again (subjects discarded one of the two similar pictures 2 or 3). This gesture, as was implied earlier (6.2), is a means by which the child declares that he has not perceived the informative value of the picture concerned (the excluded one) and that he is not aware of the difference between similar members of the pair, if one is allowed to speak of pairs.

In short, when subjects interchange pictures or exclude one of two similar pictures from their sequence, it is an indication that they



have not extracted the relevant distinctive cue derivable from a comparison between two similar frames.

With regard to the age of subjects who succeeded in the seriation task (5;9) there is no significant difference with subjects who failed in the task.

#### 6.4 Well differentiated frames: their effect on the picture ordering task.

##### Introduction:

In the last three sections, findings confirmed that subjects did not employ sufficient attention to discriminate between similar frames. However, results of section 6.2 (phase b ) suggested that this effort could be encouraged by providing the subject with the opportunity to re-analyse his sequence. Yet the typical hasty reaction of young children when they are asked to order pictures does not guarantee the positive effect of extra time spent in scrutinising a set of pictures. It seems that one would have to "force" the child to spend more time in his analysis by proposing other purposes for further investigation; otherwise the young child races through the task. If he is lucky, he will pick up the relevant information at the outset of the task but if he is not, chances are that he will refuse to spend much time weighing the pros and the cons in search of the most coherent sequences of events.

There is a way to overcome young children's natural negligence and this is by providing him with series of pictures which do not demand as thorough a concentration as the amount required to differentiate similar frames or follow simultaneous interactions between frames. This can be done by presenting him with distinctive pictures.

This brings us to speak about the material used in the following experiment:

The various procedures adopted to produce distinctive pictures were either to change the background from one frame to the other, to add a noticeable element in frames sharing the same background, such as

a new character, or to present subjects with a close-up of the "to be attended" transformation, expanding in this manner the space occupied by the relevant information. By differentiating pictures in such a way, a problem is created simultaneously. Pictures representing events portrayed in different backgrounds are known to be difficult to position in a sequence of pictures (section 5.2). In order to attenuate children's difficulty with this problem, they were told the story underlying the succession of portrayed events.

#### Material:

Three sets of five coloured line-drawings were presented to subjects (they will be presented on the next three pages).

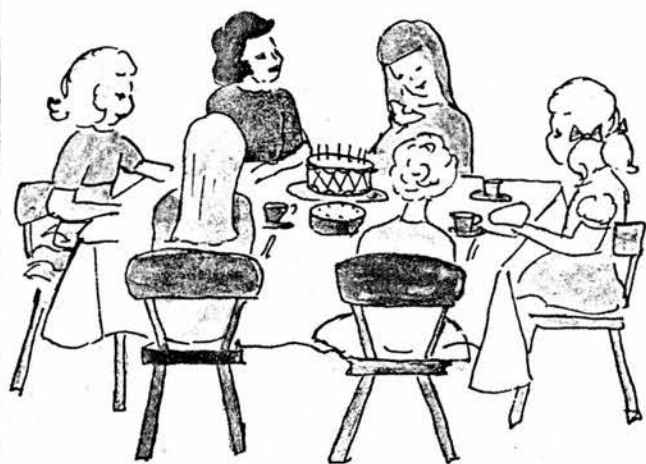
#### Subjects:

Nineteen subjects were tested with these three sets of pictures (one subject was eliminated from the original sample of 20 because she did not complete the task). Their average age was 5;9 (the youngest subject was 5;1 and the oldest was 7;1). These subjects had already been tested with the experiment reported in section 5.4.

#### Procedure:

After being told a story, the child was presented with a series of five pictures which he was asked to order according to the order of description of events.





1



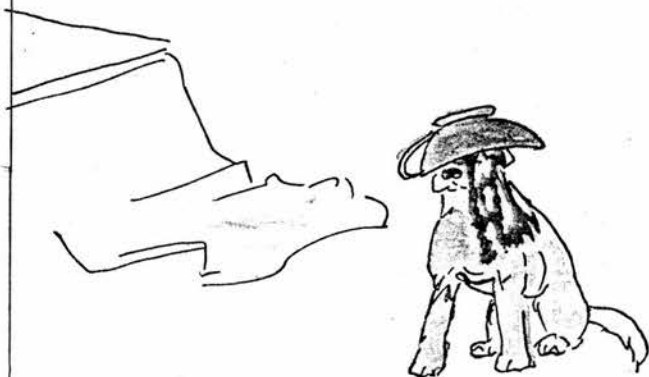
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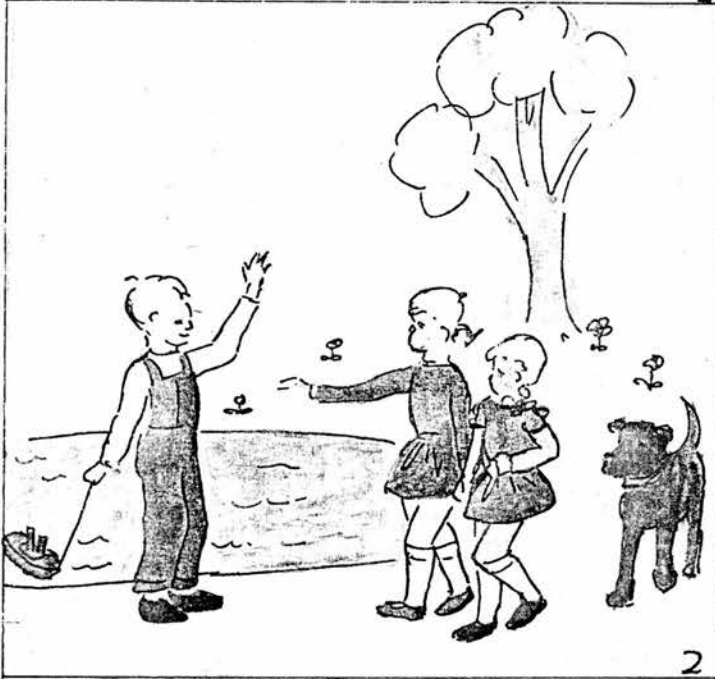
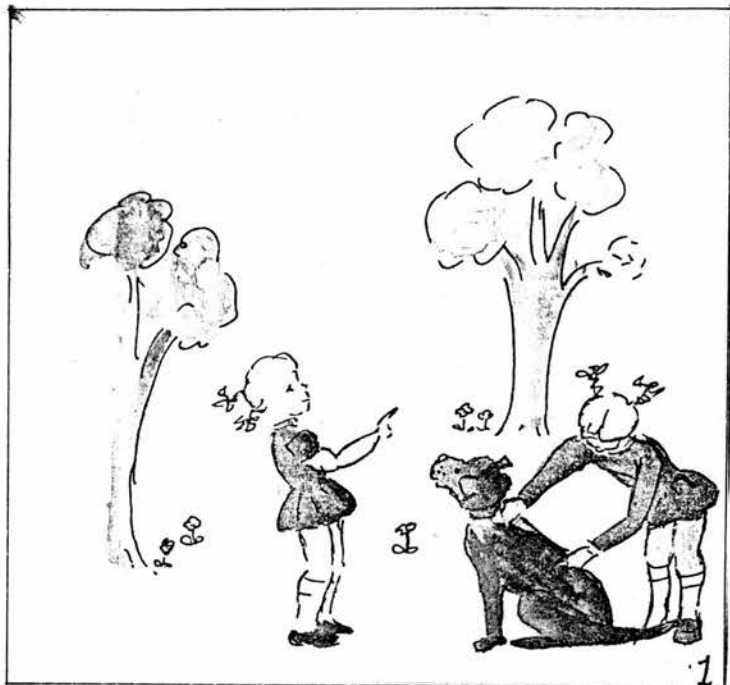
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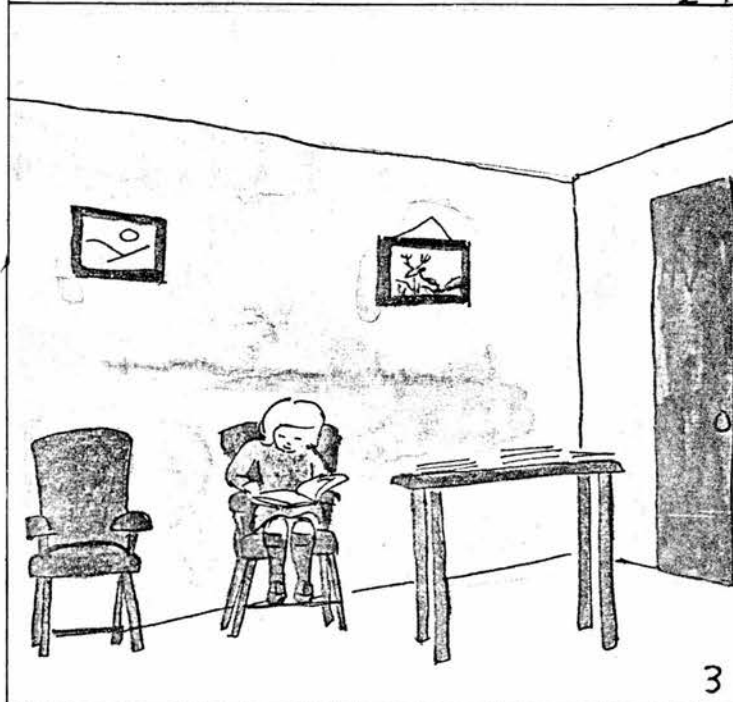
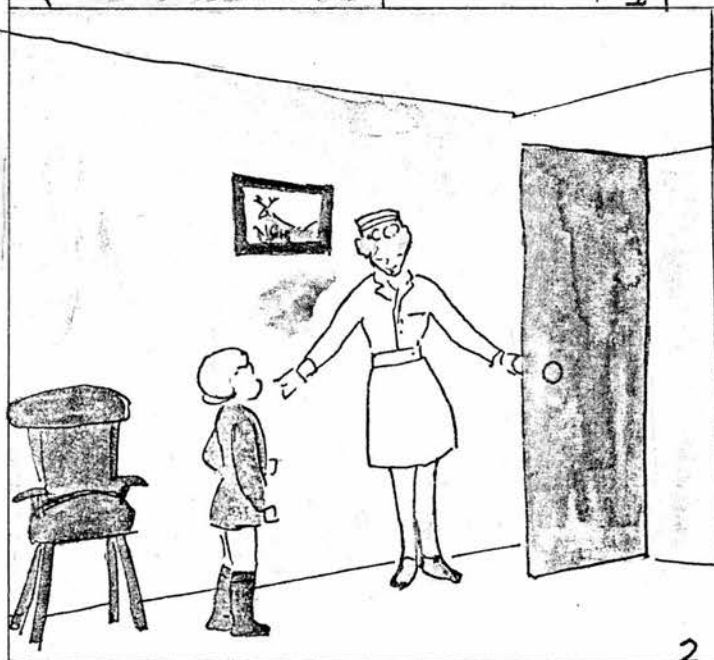


5



3







Instructions:

"I will tell you a story, I would like you to listen carefully to the story. Then I will show you the pictures that tell the story and I would like you to put them in a row just like you did before. The picture telling the beginning of the story goes on this side of the table (left) and the one that tells what happened next goes beside the first one, the next one beside ..... and the last one goes on this side of the table (right)"

Party story:

"Karen was having her birthday party tea with her friends. Her dog Sylver wanted some tea too so he put his paws on the table pulling the tablecloth down with the plates. A bowl of chocolate sauce got stuck on his head and all the chocolate started running down his face.

The girls thought that was very funny but poor Sylver was covered in chocolate so Karen got him into the bath to give him a wash.

Once the bath was over, they all went outside and played Ring around the Rosies."

King story:

"This is the story of a king and his three children and a dog. Fiona and Jane, the king's two little girls, were in the park playing with Rex, the dog. After a wee while Fiona and Jane went to see John who was sailing his boat in the pond.

Suddenly they heard someone calling them for tea so they ran back to the castle with Rex the dog rushing before them.

Rex the dog and John rushed in the dining-room knocking over the servant who was holding a tray and all their tea fell on the floor.

The king heard the noise and came in the dining-room and when he saw everyone's face looking so surprised, he thought they looked quite funny and he started laughing and everybody started laughing with him."

Dentist story:

"Jane was going to the dentist for the first time. She rang the bell and went in. She sat in the dentist's waiting room for a wee while looking at the pictures in one of the magazines. The nurse came in and asked Jane to follow her in the dentist's room.

Jane sat on the big chair and looked all over the room. Then the dentist came in and looked at her teeth and everything was fine and the dentist told Jane that she was a very good girl."

After the subject had produced his sequence he was asked to tell the story and point at the corresponding pictures.

#### Results:

Table 6.4.1 displays the scores obtained for each set of pictures. Sets are classified with the same label as the one used to describe the respective stories. Each data point represents one correct response.

Table 6.4.1 Scores obtained for the three sets of pictures.

Sets	Scores	
Party	17/19	(89%)
King	16/19	(84%)
Dentist	17/19	(89%)

The average score obtained to these three sets of pictures is 88%. Four subjects made errors because they had forgotten part of the story, another child interchanged two pictures and two misplaced a picture.

#### Discussion:

Results obtained with these three sets of pictures demonstrate an undoubted improvement in performance if they are compared with results

obtained with sets of pictures used in section 6.2 (phase b ) and 6.3. While the average score obtained with "Ronny" and "Freddy" was 67% and the average score obtained with the "animated Freddy" was 52%, the score obtained in this experiment reached 88%. A chi-square test revealed a significant difference between the condition reported in section 6.2 and the present one ( $P < 0.05$ ).

It therefore appears that children have less difficulty in coping with series of distinctive pictures than with series of less well differentiated pictures. Furthermore, the role of context or the model becomes more evident in this experimental situation if results are once again compared. While in section 6.2 and 6.3, supplying the child with a story or a film had only a partial effect on subjects' performance, in this condition it becomes a necessity.

To sum up; children's performance in this condition shows their ability to match a story with a sequence of pictures provided that pictures are well differentiated.



The rest of this discussion concerns the problem of measuring perceptual differences between frames in terms of corresponding time intervals. It has no direct relevance to the experience reported above but was derived from a cogitation on the problem of quantitative measurements.

It is very tempting to make a parallel between the perceptual difference between frames and the distance in time of the moments these frames represent: Comparing subjects' performance with various sets of pictures, it was noticed that the child could cope better with the better differentiated frames; one could say that the child could cope better with pictures representing events which were not "too close" in time. However, this statement has very little meaning if no absolute quantitative measure can be given to this distance in time between represented events (or intervals).

A reason why an absolute quantitative measure cannot be used is that the amount of time elapsed between two events cannot be derived automatically from the "size" of the perceptual difference between two frames. For instance, (pushing this argument to the limit), suppose that a comparison is made between two photographs of a yogi meditating taken at an hour's interval. If the yogi in question excels in his art, no noticeable difference will be seen between the two photographs. On the other hand, if one takes two photographs of a child playing at an interval of an hour, it would be almost impossible not to perceive the difference between these photographs.

Another solution might be more feasible. If instead of trying to find an absolute measure, one tried to find a relative one, our chances might improve. For instance, suppose that (using "animated

Freddy" as illustrative material) one out of every 10 frames is cut away from the film until 10 frames are obtained. Now, depending on how "long" each separate event lasts in the film (e.g. bouncing, kicking, crying ... ) one will obtain more or less noticeable differences between each frame. For instance, the first four frames might look almost identical while the next three might be quite distinctive. It therefore seems once again that one cannot decide on lapse of time using perceptual differences between frames in this way.

The only way out of this problem would be (using "animated Freddy" as basic material) to compare subjects' behavior with two values of time intervals. For instance, one could measure the child's performance in differentiating between frames taken from the film in the ratio of one out of nine frames compared with one out of 90 frames. Since the sampling frequency in filming is 18 frames per second, the child would see frames representing events happening at half-a-second interval in the first situation (1x9) and at five-second intervals in the second situation (1x90). Statistically, the probability of a noticeable difference existing between frames of the second situation is greater than the probability of a noticeable difference between frames in the first situation. However, if the film was about the yogi we were talking about earlier, the size of the interval between frames probably would not matter; one would get the same frames over and over.

Consequently, unless one knows exactly the duration of an event and how it unfolds in time, it becomes almost impossible to measure in terms of time perceptual differences between frames.

What emerges from this discussion is that it is impossible to dissociate time and space when one speaks of motion and that it is almost impossible to measure one dimension by way of the other.

However, all is not lost; intuition sometimes can replace advantageously the deficit in quantitative measures for which psychologists usually long for.



## CHAPTER 7

Drawing a sequence of events: a way to facilitate the child's taskIntroduction:

In the preceding chapter, the effect of the "size of the perceptual difference between frames" was studied in relation to context. It emerged from the reported experiments that, because of children's lack of attention to detailed differences between frames and because of their difficulty in following simultaneous interactions between elements, providing subjects with a model or the context underlying the structure of sequences of events was not a guarantee of success in picture ordering tasks. Findings of section 6.4 suggested that providing the child with such a model was helpful in certain conditions. These conditions are represented in situations where the child can follow distinctly the unfolding of events, i.e. when there is no confusion as to what picture represents what event.

If the child can match a picture with the verbalised event at a glance, his chance of success in ordering a whole series of pictures in the appropriate sequence is enhanced. On the other hand, if the child has to struggle to match a picture with the verbalised event because he cannot decide which picture represents a particular event, his chance of producing the appropriate sequence is threatened.

It has been observed many times that young children do not offer much resistance when they are put in front of a difficult decision of this sort. If they cannot figure out the position of one of the pictures of a set, they simply leave it out of the sequence or place it beside a picture with which it shares similar features.

It is quite amazing to witness the transition taking place in the child's behavior or across a sample of children of different ages. The child seems to evolve from rushing through a task more or less carelessly towards a stage where he spends some time pondering the task trying to solve the presented problem. Older children are also generally more careful in their approach but quicker and more prone than younger children in finding solutions.

The aim of the present chapter is to test another means by which a child can produce a coherent sequence of events. Since the young child tends to overlook some of the available cues in pictures, a way to avoid this problem is by getting him to produce his own representations of events by drawing them. In this way the problem of differentiating similar frames should be eliminated since the child will represent events with the perceptual differences and the time gaps that he chooses. Moreover, since he will not be forced to cope with a determined number of frames (e.g. five frames were presented in Freddy's story), he will delimit the information load he can cope with.

It will be interesting to compare the results of a child's performance in a situation where he is asked to deal with a determined amount and form of information with a situation where he is free to choose what events he wants to represent, how he wants to represent them and how many events he wants to portray.

The facilitating conditions described above should have a sensible effect on the child's performance. Consequently in the drawing condition children are expected to produce well seriated series of pictures with a higher frequency than subjects usually did in conditions reported in sections 6.2 and 6.3 ("Freddy's narrated



story" and "animated Freddy"). In order to compare subjects' performance with these three conditions, the child will be asked to produce a sequence of pictures to match Freddy's story.

#### Material:

Freddy's story narrated in section 6.2 was also told to this group of subjects. Subjects were provided with paper and wax crayons; the strip of paper measured approximately 15 inches wide (37 cm.) by 55 inches (138 cm.) long. More paper could be obtained on subjects' demand.

#### Subjects:

Twenty subjects were presented with the drawing task. Half of these subjects were naive subjects and half of them had been tested before with the experiment reported in section 6.3. These subjects attended Primary 1 classes in an Edinburgh school. The average age of the naive subjects was 5;10 (children's age ranged between the ages of 5;6 and 6;1) and the average age of the subjects who had previously been tested was 5;7 (their age ranged between the ages of 5;6 and 6;1).

#### Procedure:

The reason why both naive and experienced subjects were tested in this experiment was to see if children who had already some knowledge of the story and of the way events had been represented would be influenced by this supplementary information.

Subjects were told Freddy's story, then they were asked to recall it before drawing the story. Once they had finished their drawings subjects were asked to retell their story pointing at the corresponding pictures.



### Instructions:

"I will tell you the story of a little boy called Freddy. I would like you to listen to the story carefully because I will ask you to tell the story after me. After that I would like you to draw pictures telling Freddy's story just like in a story-book (picture book). In the book you have the first picture telling the beginning of the story, then another picture telling another bit of the story until you get to the end of the story-book where the last picture tells the end of the story.

You can draw as many pictures as you want. I would like you to start on this side of the paper (left) and go on to the other side. If you want more paper just tell me".

When the analogy between the child's drawings and a story book was made, pages of a story book were flipped through showing the child what was meant by the first picture telling the beginning of the story and the last picture telling about the last event. The purpose of this demonstration was to make sure that the child realised that he would have to draw several pictures representing various events and in a particular sequence.

### Results and discussion:

Since the experienced group showed no advantage over the naive one, both samples' results were pooled together.<sup>6</sup>

Subjects portrayed an average of 3.5 events in their drawings and mentioned an average of four events when describing their pictures. In four cases a single picture was drawn to represent the whole story, however, when the child was asked to draw events individually three out of these four subjects responded accordingly. Luquet (1924) labelled this type of drawing in which noncontemporary events figure but in which the characters are not repeated "dessin a juxtaposition". He observed that 80% of children of 6 and 7 years

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<sup>6</sup>No difference in the nature and number of represented events and in the order of sequences of drawings was found.

produced such drawings. Yet in the present experiment very few of these "dessin a juxtaposition" were noticed (the four subjects who did, were experienced subjects).

Subjects' drawings were produced in 75% of cases in the order corresponding to the narrated sequence of events. Yet all subjects pointed to the appropriate picture when retelling the story. This finding demonstrates that the child knows very well which event follows another event but he might find it arbitrary to juxtapose drawings in an order which parallels the narrated sequence of events.

Table 7.1 Frequency of representation of the five main events.

Events	Frequency
1. Freddy playing with the ball	90% (18/20)
2. The ball goes on the roof.	95% (19/20)
3. Freddy's dad is watching in the window	50% (10/20)
4. The ladder rests on the house, the ball is on the roof	50% (10/20)
5. The daddy is climbing up the ladder	75% (15/20)
5. Freddy is playing with the ball, the dad is present	60% (12/20)

It appears from Table 7.1 that some events are more popular than others in children's drawings, namely events 1 and 2. As far as the fourth event is concerned, there were two ways of representing it: 50% of the subjects represented the relation between the ladder, the house and the ball and 75% of subjects represented the father climbing up the ladder (within this 75% of subjects 25% only represent



the father and the ladder while 50% of subjects represent the relation with the house and the ball as well).

Before the child was asked to produce his series of drawings, he was instructed to retell the story he had just been told. This precaution was taken to make sure that the child had retained the principal events of the story. The subjects' report of the story was recorded and compared with the content of his drawings. While only two subjects mentioned that Freddy's ball was red, 16 subjects drew a red ball. In another similar instance, one subject mentioned that "the daddy was watching in the window" while ten subjects represented a man in a window. These observations reveal that subjects might store more information than they chose to reveal when they recall a story. (Researchers in the field of child memory could find that coupling these two forms of output (story and drawing) is a useful means of measuring the child's memory capacity.)

A look at subjects' sequences of drawings reveals subjects' little concern for uniformity. In fact size and colour of objects vary from one frame to the other except for the ball which remains red throughout the series in 70% of cases. Only one subject showed any concern in giving her drawings any uniformity; she kept looking at her preceding drawing as she was producing a new one. Other children behaved as if they wanted to try out all the available crayons in the box. A feature which conserved more uniformity throughout subjects' sequences was the shape of objects. In fact, 70% of subjects conserved the same shape for their houses and 80% for their characters. This uniformity might be explained by subjects' habitual drawing technique rather than by a genuine concern for uniformity.



What becomes quite interesting relative to what was said earlier about children's difficulty to appraise differences between frames, is that very often the child will only reproduce the relevant or salient difference distinguishing two represented events. In doing so, he overcomes the problem of having to compare scrupulously contiguous frames. This behavior also demonstrates that the child's problem is not a question of "potential understanding" of the nature of a difference (since he can portray it) but rather a question of actually "detecting" this difference when he is asked to do so. An example will illustrate how a subject portrays successive events. After he has drawn Freddy playing with his ball (frame 1), the child draws a roof with a ball on it (frame 2). The third frame represents Freddy's father going up a ladder to get the ball. The way in which this scene is represented is by portraying a ladder touching the roof with a man climbing on it. There is no house to support the roof and the ladder in the child's drawing. There is no house to support the roof in frame 2 either. Only what represents the transformation from one frame to the other is portrayed in the child's drawing.

Comparison of this condition with conditions reported in sections 6.2 and 6.3:

A comparison between these three conditions reveals that subjects did better in the drawing condition than in the two previously reported conditions. In fact, the average score obtained in the first condition (section 6.2: ordering five pictures with Freddy's story serving as a model) was 60%, the average score obtained in the second condition (section 6.3: ordering five pictures using "animated Freddy") was 52% while in the drawing condition 75% of subjects drew

events in the adequate order although all subjects in this last condition pointed out the appropriate picture when telling the corresponding story.<sup>7</sup>

If individual results obtained by the ten experienced subjects who participated in both the film condition and the drawing condition are compared, one finds that subjects who had done well in the film condition also did well in the drawing condition ( $N=4$  subjects). The four subjects who did poorly in the film condition did well in the drawing condition, while two subjects did poorly in both conditions. If the average score of these ten subjects in the two conditions is compiled, one obtains  $4/10$  for the film condition and  $8/10$  for the drawing condition, which shows an appreciable improvement from the film condition to the drawing condition.

#### Conclusion:

Subjects' performance in the drawing condition indicates that they have a good understanding of the concept of order of events even though some of them are not too concerned with the way they draw their succession of events.

The drawing technique appears to facilitate the subjects' task in many ways:

1. The child is free to illustrate the number of events he chooses to. In this condition the average number of drawn frames was 3.5 which suggests that the child could cope better with three or four frames rather than five (five frames were used in conditions reported in sections 6.2 and 6.3).

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<sup>7</sup>With practice, it is possible that subjects could learn to draw pictures in the appropriate order since they already know how pictures should follow.



2. The child chooses to represent events he feels important.

Table 7.1 reveals that three events were treated as more important (1-2-4). These results also suggest that some of the events represented in frames used in the two other conditions were probably not considered as "important" by children. In fact, one can recall that often pictures 2 or 3 and pictures 4 or 5 were treated as similar or redundant. One picture of the pairs was often left out of the series altogether. Findings in this condition support the "informative value hypothesis" which was put forward in section 6.2

3. The child chooses the way in which he wants to represent successive pictures. Earlier on, we saw that children often simply represented the transformation taking place between two events, leaving out the background and the actors. Representing only the salient difference between two successive frames confirms the idea that children can cope better with well differentiated frames than with frames in which relevant cues are camouflaged by the amount of redundant information.



## CHAPTER 8

Children's ability to insert "extra" pictures in  
a sequence of represented events

Introduction:

This study was the last of a series of pilot studies. Its primary aim was to investigate children's ability to insert in a series of pictures represented events which had not been explicitly mentioned in the story.

This experimental condition is considered the most difficult task subjects have been asked to perform. It is therefore expected that subjects' performance with this experimental condition will not reach the standard that had been reached in the previously analysed conditions. The reasons for which this task is considered difficult will be put forward in the following paragraphs.

Previous experiments have demonstrated that subjects could use a narrated story effectively as long as the pictures presented were well differentiated (section 6.4). In such a case, all the child had to do was to produce a one-to-one correspondence between the narrated events and their pictorial representations. In the experimental condition analysed in this chapter, the child will not be allowed this one-to-one correspondence since some of the represented events will not be mentioned in the story.

A certain analogy can be established between the seriation condition studied here and a seriation condition in which subjects are asked to insert rods into their original series of rods.

Piaget's work (1952) with this type of seriation task shows that even though young children can produce a seriation of rods they have a lot

of difficulty in inserting extra rods of intermediate sizes in their already constructed series. Elkind's interpretation (1968) of the child's deficiency is that the child has a model of the first staircase made by the experimenter (an internal model) and when he is asked to insert extra rods, his first model is no longer of any help to him since it does not account for the intermediate size rods. In the picture seriation task, the child will be faced with the problem of having to deduce from the information provided in the story, the position in the sequence of these extra or intermediate events.

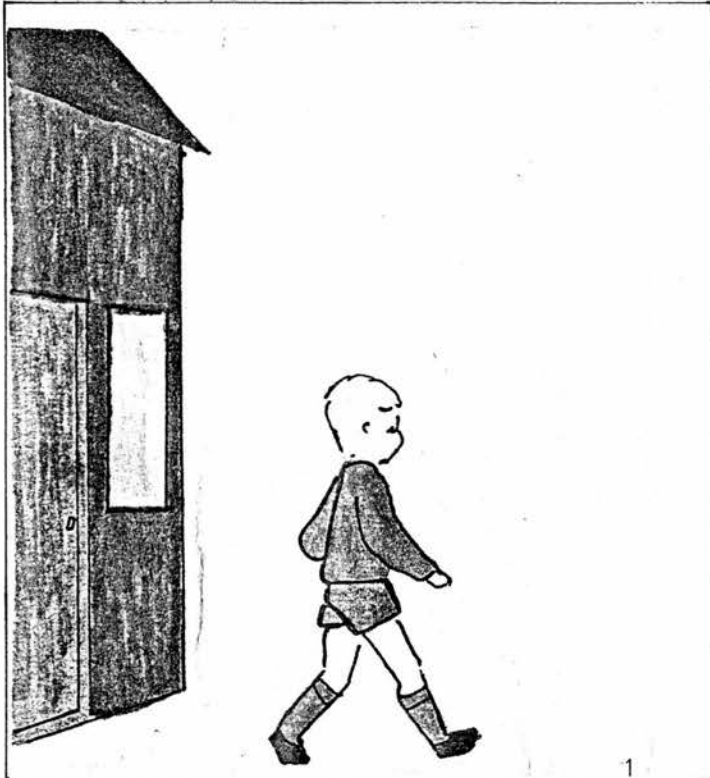
To add to the complexity of the task some of these extra pictures were made very similar to some of the ones representing the mentioned events. Since evidence recorded in chapter 6 demonstrated that subjects could not always cope with pictures sharing similar features, one expects to find the same failure here again. Another difficulty which can be added to the list, is the increase in the number of pictures presented (11 pictures compose the set).

#### Material:

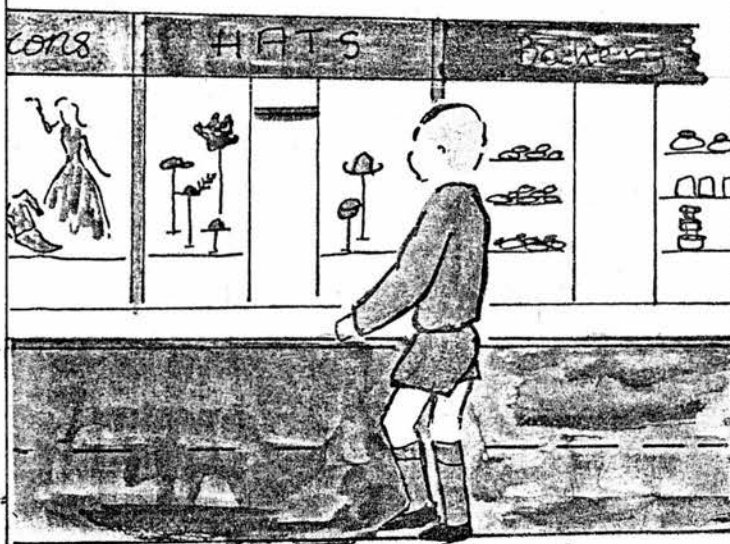
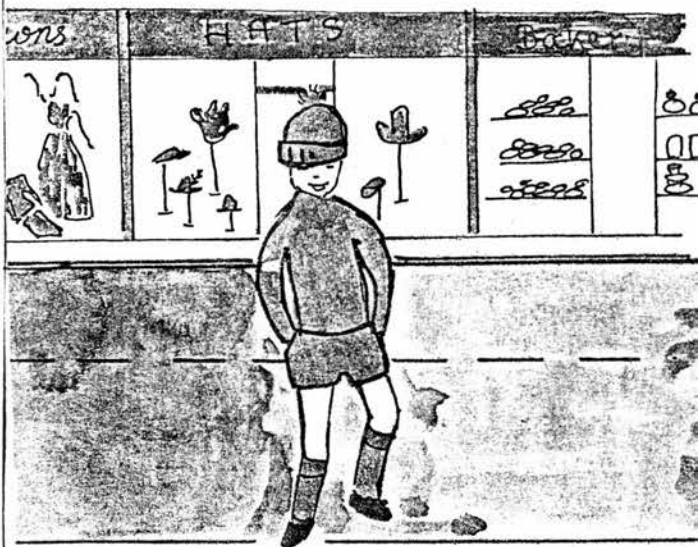
Eleven coloured line-drawings composed the presented set (they are presented on the following two pages). The pictures representing events explicitly referred to in the story are pictures 2-3-6-8-10-11.

#### Story:

"Mike went to a shop to get himself a hat. Mike got himself a nice red hat from the shoplady. Back home, Mike put his hat on the hook; Mike's sister put his hat on the dog's head. Mike got his hat back and put it back on the hook."



1



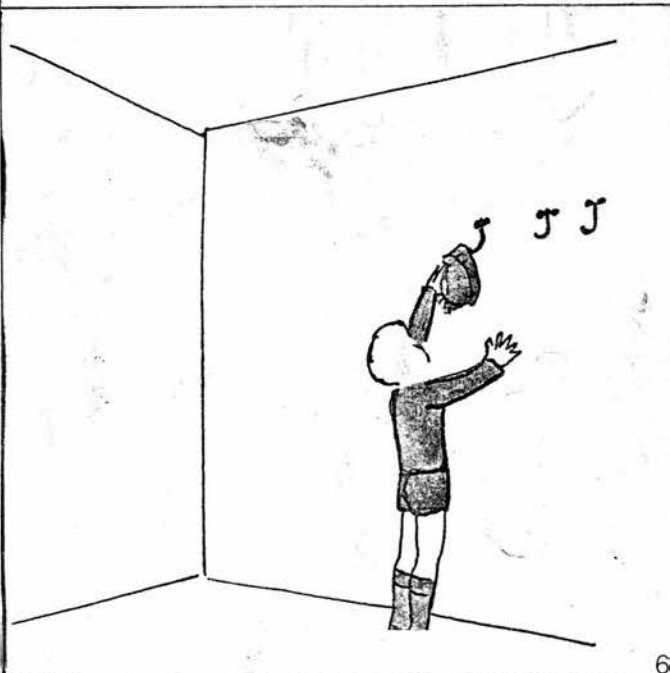
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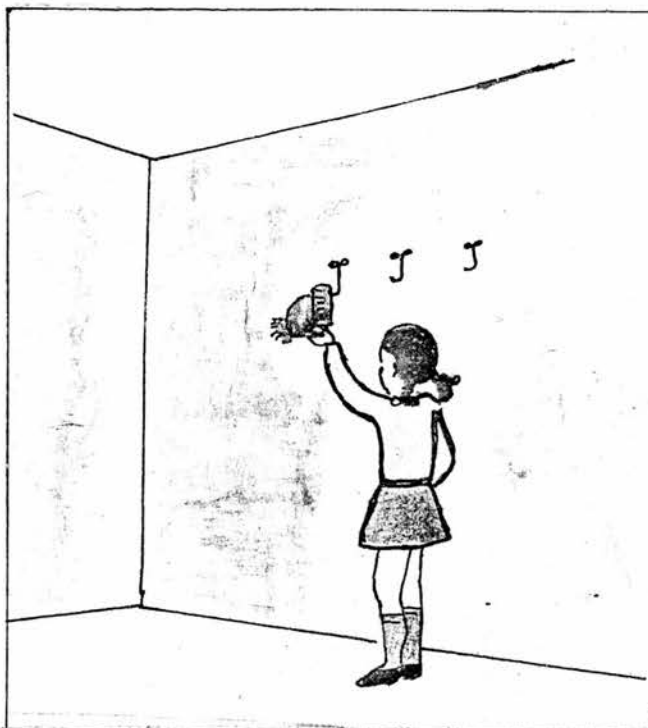


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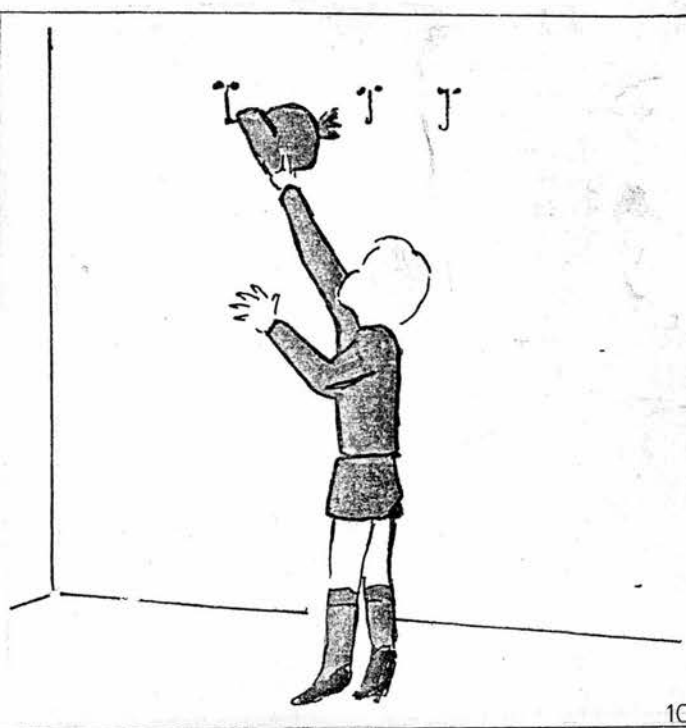


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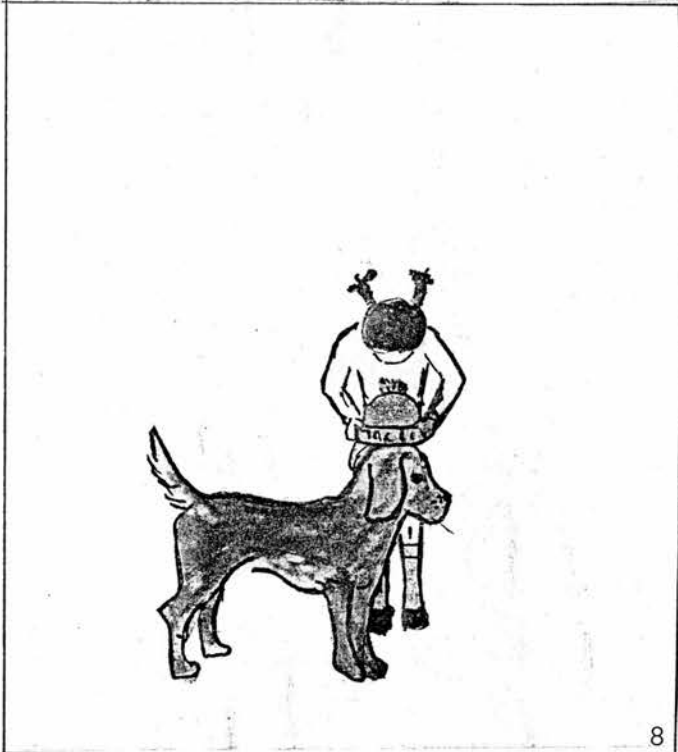




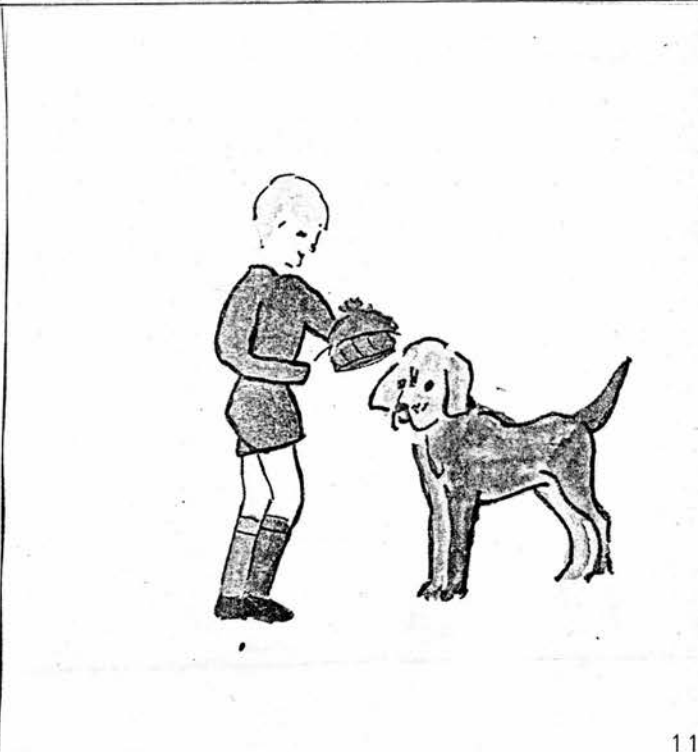
7



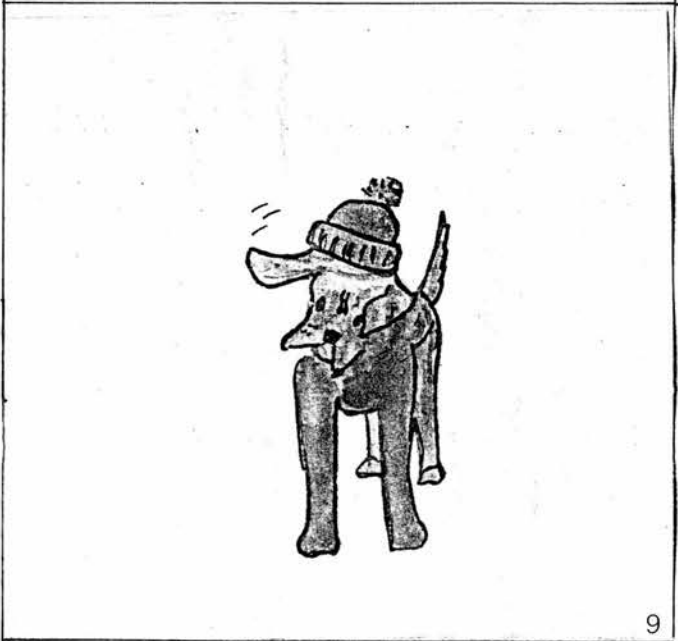
10



8



11



9

Subjects:

Twenty subjects were presented with the picture ordering task. These subjects of an average age of 5;10 (subjects' age range was between 5;3 and 7;1) had been tested in previous pilot studies except for the oldest subject who was a newly arrived pupil.

Procedure:

Subjects were seen individually and told once again that they would have to order a series of pictures according to a story. After they had recalled the story, subjects were presented with the 11 pictures in random order and asked to order them. Once the sequence was produced, the child was asked to point out pictures corresponding to his story as he was telling it once again.

Instructions:

"I will tell you a story, I would like you to listen carefully to the story. Then I will show you some pictures that tell the story and I would like you to put them in a row just like you did before. The picture telling the beginning of the story goes on this side of the table (left) and the one that tells the end of the story goes on that side of the table (right)".

Before the child produced his sequence he was asked to recall the story in order to see if he had stored the main events of the story. He was also asked to retell the story when asked to justify his choice of sequence.

Results:

Five out of the 20 subjects (25%) produced the adequate sequence on first trial while four other subjects managed to produce the appropriate seriation after a second trial (45% of success if one includes first and second trials.) The average age of subjects

who produced appropriate answers on first trial is 6;3, the age of subjects who produced appropriate answers on first and second trial is 6;1 and the age of subjects who produced inappropriate answers is 5;8.

When subjects were asked to retell the story along with the justification of their sequence, they managed to report an average of 5.3 main events (between three and eight events); the story mentioned six main events.

#### Categories of errors:

Table 8 shows the categories of errors produced in this task as well as the number of subjects who committed the various errors.

Table 8    Distribution of subjects' errors in categories of errors.

Categories of errors	Number of errors
Excluding pictures from the sequence	10
Interchange of pictures	1
Pairing similar pictures	3
No coherent order	2

As illustrated in Table 8, children's main fault was to exclude pictures from their series. The pictures which were discarded most often were pictures 4 (five times), 5 (five times), 9 (four times), 1 and 2 (three times), and 7 (twice). Subjects



discarded between one and five pictures. Pictures sharing the greatest number of common features, such as pictures 2 and 4 and pictures 1 and 5, were paired in the sequence by two subjects. Two other subjects could not produce a coherent sequence even after many trials.

### Discussion:

Since the success of seriating correctly this set of pictures belongs to the oldest subjects, it seems that children over 6 years of age have a greater chance in succeeding in this type of task than their younger companions.

Three explanations emerge to justify children's dismissal of so many frames from their series: 1 - the great number of frames (11), 2 - the ignorance of subjects of what action to take with pictures not explicitly referred to in the story (i.e. pictures 1-4-5-7-9), and 3 - the fact that they could not appreciate the difference between pictures 2 and 4, and 1 and 5, i.e. they treated these pictures as expressing redundant information.

To summarise the situation, it seems that subjects excluded pictures from their series either because they represented events which had not been referred to in the story or because they tended to eliminate pictures sharing numerous common features as redundant. However, the fact that not only these similar types of pictures were discarded from subjects' series (1-2-3-4-5-6-7-9) turns the scale towards the first hypothesis, (i.e. excluding pictures which had not been referred to in the story). It would seem, according to this interpretation, that children have as much of a problem in inserting not explicitly mentioned representations of events in a

sequence than they have in inserting rods of intermediate sizes in their already constructed series of rods.

In chapter 6 (sections 6.1-6.2-6.3) it was seen that providing subjects with "easy context" situations or a model (Freddy's story and animated Freddy) helped subjects to organise series of pictures. Yet, situations where frames were well differentiated provided a situation where such a model showed its most sensible effect. The evidence gathered in this section adds another piece of evidence to what is already known about the effect of a model on a picture ordering task. Results suggest that most subjects only benefited from the story in as much as it helped them to order pictures representing events explicitly referred to in the story. Subjects did not use this information to infer the position of the intermediate moments.

The oldest subject tested in this experiment was given an extra and more difficult test. She was asked to make up a story with the eleven pictures before she was told the story. She managed to produce a coherent story; only the last part of her story differed from the one used here as a model. When she was told the actual story and was asked to match her sequence with this story she had no problem whatsoever in reorganising her sequence. This result might indicate that children around the age of 7 have the necessary flexibility and attention to produce coherent sequences of events.



## 8.2 A post-test with 6 to 8 years old subjects.

In order to verify the proposition made at the end of the last section of chapter 8, a post-test was carried out. A further sample of 29 subjects between the ages of 6 and 8 years old (the youngest being 6;0 and the oldest 8;5) were tested with the same picture seriation problem. It should therefore be possible to obtain more precise information on the age at which children can solve this type of problem.

Table 8.2 represents the level of performance obtained to the picture seriation task.

Table 8.2 Scores obtained to the picture seriation task.

Age	Score
6-7 (N=15)	60% (9/15)
7-8 (N=14)	85% (12/14)

Figures displayed in Table 8.2 show that subjects over 7years old do master this type of seriation problem better than their younger companions.



## CHAPTER 9

A comparison between the child's performance with picture seriation tasks and rod seriation tasksIntroduction:

The evidence recorded in the previous chapters on children's reactions to picture seriation tasks have led us in making some suggestions as to how the child's performance in picture seriation tasks might compare with rod seriation tasks. The purpose of the present study is to evaluate the cogency of these assumptions and to analyse developmentally the child's evolution in both types of seriation tasks.

In order to proceed in this task, Piaget's (1952) and Young's (1973) studies on the rod seriation task will be discussed. Furthermore, a revision of certain points of the discussion carried out in chapter 6 (section 6.1) where reference was made to children's behavior with the more classical type of seriation task as well as information gathered on children's picture seriation abilities will provide the basis on which to propose the hypotheses tested in this study.

Piaget's theory concerning the child's seriation abilities has been drawn in the introductory part of this dissertation in the context of a portrait of the preoperational child (section 1.1). Other evidence has also been made available recently by Young (1973) who has analysed 4 to 6 years old children's strategies in producing rod seriations. Young's results were compatible with most of Piaget's results, however, he proposed a new approach to the problem. In place of the picture of successive re-structurings by a "stage" analysis, the child's progress from initial failure to later success has been

shown to consist "in the progressive accumulation of production rules". As far as Young is concerned, previous studies of seriation have stressed the uniform, algorithmic-like character of operational seriation and have tended to regard it as in some way optimal.

Young suggests that advanced seriation consists of a collection of rules capable of performing the task by any of several different methods; advanced seriation is "adaptive" (Young p. 240).

The developmental trajectory traced by Young (p. 241) follows this pattern: it starts by a mere arrangement of the blocks into a line with no attempt at ordering; as rules are added it advances step by step through partial seriation, seriation by trial and error correction and on to "operational" seriation by selection. According to Young, no special mechanisms are needed to account for the observed pre-seriation phenomena. They are adequately explained by the mere absence of one or more of the rules required for successful seriation.

A common finding of both Piaget and Young is that children evolve in their capacity of seriation between 4 and 6 years old. Even though very young children do grasp the meaning of the concept of order in some instances (cf. discussion p. 161), even though they can discriminate between an ordered series of blocks and an unordered series of blocks at 4 years old (Young 1973) and even though they can draw a series of rods in an adequate order before they can produce an integrated seriation, they do not master this concept of order in its totality since they cannot manipulate it in all instances. For Piaget and Inhelder (1964), the problem lies in that the child is preoccupied with the overall shape of the configuration at the expense of the elements which compose a series. The child's approach



is global rather than analytic and it is not yet reversible. For Young the child's problem lies more in the absence of a definite set of rules or strategies than in the misunderstanding of the concept of order as such.

Concerning picture seriation tasks, some of the preoperational child's characteristic behaviors in the classical seriation task were also apparent. For instance young children were found to have some difficulty in differentiating between similar frames, they tended to mix them up or exclude them from their sequence. An attribute of sequences of pictures which also rendered the ordering task difficult was the representation in each frame of the sequence of simultaneous interactions between elements. Indeed, subjects tended to concentrate on single interactions instead of considering all "contemporary" events. Nevertheless, 5 years old subjects were able to order, with a fairly high level of success sequences of three pictures representing quantitative transformations as well as the position and the presence-absence classes of transformations.

In chapter 6 (section 6.1) subjects were presented with "easy-context" picture situations i.e. with series of pictures representing classes of transformations which had appeared to be easiest to interpret in previous tests. Results showed that the child indeed had no difficulty in interpreting the quantitative class of transformation as such but that his difficulty lied in differentiating between similar frames. Discussing these results, it was suggested that the familiarity and the inherent logic of the picture situations presented might explain the advantage of these particular types of seriation tasks over the classical seriation tasks.



In the following experiment an attempt will be made to clarify this hypothesis as well as establish a parallel between subjects' performance to both types of seriation tasks. If indeed easy-context, straightforward picture seriations are easier to understand than the classical seriation task for young children one would expect 5 to 6 year olds to do as well as the older subjects in the "Ice-lolly" picture situation, the "Glass" picture situation having been complexified for some other purpose.

#### Method:

In order to assess more directly the child's performance with the two types of seriation tasks, it appeared necessary to find a common criteria from which to initiate the comparison. This justifies the choice of material which will be used in the experiment.

The experiment comprises a rod seriation task (with three levels of difficulty) and two picture seriation tasks (with three levels of difficulty) all representing a size transformation between each element of the series. For the rod seriation task, the variation in size is represented by rods of various lengths and for the picture seriation tasks, the variation is represented by frames portraying an object submitted to a size transformation.

Concerning the three levels of difficulty involved in these tasks, the difficulty consists in decreasing the perceptual difference between the rods or the pictures and in increasing the number of rods or frames presented to subjects as one goes up in the scale of difficulty. Another type of difficulty was added to one of the two picture seriation tasks (the Glass picture situation). This difficulty involved representing an event composed of two simultaneous size transformations as opposed to a single one. Results presented

in chapter 6 (sections 6.2 and 6.3) indeed showed that young subjects have more difficulty in dealing with sequences representing simultaneous interactions between elements.

#### Hypotheses:

Taking into account the child's difficulty described above, it is expected that the "Glass" picture situation will obtain a lower score than the "Ice-lolly" picture situation.

According to pilot tests performed at the outset of this research, (cf. appendix 1), it is also expected that the youngest subjects to be tested (4 to 5 year olds) will offer a fairly poor performance compared to the older ones and, according to Young's research, that they will also demonstrate great difficulty in rod seriation tasks, even with the simpler ones.

Concerning tasks of various levels of difficulty, one would also expect subjects' performance to decrease in quality as the task becomes more difficult. However, if results similar to Young's are obtained with 4 year olds (i.e. when presented with the three block seriation these subjects failed to order them), these subjects should maintain their poor performance throughout all three tasks since they have difficulty with even the easiest task. As far as the oldest subjects are concerned (6 to 8.5 year olds), it is expected that their already tested abilities in both types of tasks will remain fairly even throughout tasks of various levels of difficulty. The variance should be more apparent with subjects between 5 and 6 years of age according to previous experiments.

Because of the increase in the size of the sample and the wider range of age of the sample a clearer developmental portrait of children's performance should transpire from these results.



Even though this experiment involved only picture serialations representing size transformations, other classes of transformations will also be considered when results are discussed.

### Material:

#### rods:

Two sets of rods were used with subjects between 4 and 5 years old. The first set comprised six plain rods (3cm.-7cm.-11cm.-15cm.-19cm.-23cm.). The second set comprised 10 Cuisenaire rods (A, B, C, D, E, F, G, H, I, J ). Subjects over 5 years old were tested with the Cuisenaire rods.

#### pictures:

Two sets of pictures were presented. One set: "Ice-lolly" represented a boy eating an ice-lolly and the other set: "Glass" represented a girl pouring juice from a pitcher into a glass. This set of pictures portrayed two simultaneous transformations: the quantity of juice increasing in the glass and the quantity of juice decreasing in the pitcher while the other set portrayed a single transformation (pictures are presented on the next pages).

### Subjects:

Sixty-nine subjects were tested and divided into four groups: 20 subjects between the ages of 4 and 5 years old composed group A; their mean age was 4;6 (4;2-4;11); group B comprised 20 subjects between the ages of 5 and 6 years old; their mean age was 5;6 (5;1-5;11); group C comprised 15 subjects between the ages of 6 and 7 years old; their mean age was 6;5 (6;0-6;8); group D comprised 14 subjects between the ages of 7 and 8;5 years old; their mean age was 7;7 (7;1-8;5).

These children attended either pre-school classes (4 and 5 years old), either kindergarten (5 and 6 years old) or first and



ICE-LOLLY



A



B



C



D



E



F



A



B



C



D



E



F

second grade (6 and 8 years old) classes. They came from a middle class background and were considered by their teachers as "normal" children.

### Procedure:

#### rod seriation:

A pilot test was done with subjects between 4 and 6 years old to attest their understanding of the rod seriation instructions. It was then decided that instructions for group A subjects should include more details as well as an easier test. This is the reason why group A subjects were presented with an extra rod seriation task (see material).

#### picture seriation:

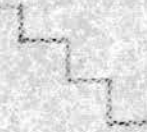
Subjects between the ages of 4 and 7 years old were presented with the pre-test described in chapter 5 (5.2). Older subjects were simply asked to order a three picture series in the left-right order since they were already familiar with picture seriation tasks.

#### procedure and instructions for group A subjects:

Since the experiment involves two types of seriation tasks, instructions were divided into two parts. For half the subjects part 1 of the instructions (for the rod seriation task) was given first and for half the subjects the second part (for the picture seriation task) was given first. The next paragraphs describe the procedure for the rod seriation task which was given at the outset of the session for half the subjects followed by part 2 instructions which were given at the outset of the session for the other half of the subjects.

#### part 1:

At the outset of a session with 4 years old subjects, a subject was asked to describe a staircase, its function... He was then shown a drawing and asked if he recognized a staircase.





He was then shown another drawing and also asked if he recognized a staircase.



After the child had acquiesced, he was given

three plain rods (3cm.-11cm.-19cm.) and asked if he could make a staircase, with steps either going up or down. He was then presented with the remaining three plain rods (i.e. six rods) and asked to build another staircase. If the child did not understand that rods were to be placed side by side as in the drawing, he was shown the drawing once again and asked to build his staircase in that manner. He was then asked to order three cuisenaire rods (i.e. rods A,E,J).

#### part 2:

The pre-test presented in chapter 5 (5.2) was presented to subjects (the experimenter produced three different shapes with clay and presented the subject with pictures representing these shapes. The subject was asked to order the pictures in correspondence with the order of occurrence of the events). Subjects were then presented with three frames (A,D,F of either "Ice-lolly" or "Glass") and asked to decide what the person had done first, next and last and to order pictures accordingly. (Instructions are recorded on p. 115). Subjects were also asked to justify their answer.

In order to balance evenly the experiment subjects were presented with a rod seriation test (first level of difficulty, e.g. A,E,J) followed by a picture seriation test (first level of difficulty, e.g. A,D,F) or the reverse (i.e. a picture seriation task followed by a rod seriation task). They were then presented with the sets of three rods or three pictures of the second level of difficulty (i.e. rods A,B,C or H,I,j or pictures D,E,F of "Ice-lolly" or "Glass"). The difficulty of this second level task held in that three successive

pictures or rods of the series were presented decreasing in this way the difference in size between the elements. The third level of difficulty involved, for the rod seriation task, ordering five rods (e.g. A,C,E,G,J). Subjects were then presented with the five remaining rods and asked to intercalate them in the series.

Concerning the third level of difficulty of the picture seriation task, subjects were presented with all six frames (either "Ice-lolly" or "Glass" first) and asked to order them in the proper sequence. In order to clarify this procedure, a diagram is presented in Table 9.1.

Table 9.1 Diagram representing the order of presentation of the 2 seriation tasks in two forms.

Form 1	Form 2
Instructions part 1 (rod)	Instructions part 2 (frames)
Instructions part 2 (frames)	Instructions part 1 (rods)
Rod 2nd level (A,B,C or H,I,J)	Frames 2nd level
Frames 2nd level (D,E,F)	Rod 2nd level
Rod 3rd level (5rods-10 rods)	Frames 3rd level
Frames 3rd level (6frames)	Rod 3rd level

procedure for the remaining subjects:

The procedure was essentially the same for these subjects except that part 1 instructions did not include the use of the plain rods. Subjects were presented with seriation tasks of the three levels of difficulty.

Instructions concerning the rod seriation task were much simpler for subjects over 6 years old since they were familiar with the task



of rod seriation and understood the meaning of the phrase: "to set rods in order of size". As was said previously group D subjects were not presented with the pre-test preceding the picture seriation task.

### Results and discussion:

Before displaying results obtained to this experiment, reactions of 4 to 5 year olds to the first rod seriation task will be analysed.

Pilot studies revealed that these young children have no understanding whatsoever of the task of "setting rods in order of size". They do not interpret the instruction of "building a staircase" as "seriating a series of rods side by side in an increasing or decreasing order". Even though subjects were shown drawings of staircases



model 1      model 2

most of them could not reproduce a

series of rods in the fashion proposed by model 2. The types of reactions recorded in this experiment are not usually reported in the literature, all that is usually said is that young children do not attempt seriations.

Children's first response to the instructions of "building a staircase" were varied. Here are a few examples showing the way in which these instructions were interpreted.

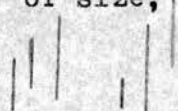



Some children also piled up the rods in no specific order.



Instructions used by Piaget (1959) for the rod seriation task involve two types of directives: "Tu vas mettre ces bâtonnets par ordre de grandeur" (order by size) or "tu vas faire un escalier en mettant les bâtonnets l'un à côté de l'autre" (build a staircase).

Even though it is known that young children demonstrate an inability to produce seriations of rods for a various number of reasons, one would at least expect instructions to be clear enough to be understood by young children otherwise it is difficult to know what one is measuring when an inadequate response is given. It was found, in this experiment that the classical instructions (Piaget's) used for rod seriation tests were totally inadequate for young children and that some effort should be invested in finding an adequate way of communicating to the child what is expected of him. An effort was made in this study to clarify instructions, but it might not have been sufficient since according to some subjects' reactions one was not always sure if the child understood what was asked of him. However, when an actual series was built in front of the child (with 6 plain rods) and when his attention was drawn towards the increasing or decreasing levels of the "steps" of the staircase, some children understood that rods should follow side by side with "steps" of increasing or decreasing size.

Nevertheless, grasping these instructions did not prevent subjects from making errors. Their response was either to place rods parallel one to the other, in no particular order of size, displacing the top of the rods so that steps appeared  or either to consider the "side by side" part of the instructions leaving out the part concerning the steps. 

A total of 621 answers were compiled and analysed according to a various number of factors. Answers to the picture seriation tasks were treated as correct when they were properly justified otherwise they were classified as incorrect.

Table 9.2 displays the percentage of success obtained to the three seriation tasks (at the three levels of difficulty) by each group of subjects: group A (4 to 5 year olds), group B (5 to 6 year olds), group C (6 to 8 year olds). Group C and group D were melted into a single group since their performance was almost identical. Children over 7 years of age made no mistakes in the three seriation tasks; any mistakes recorded in Table 9.2 are attributed to the 6 to 7 years old subjects.

Table 9.2 Percentage of success obtained to the 3 seriation tasks by the 3 age groups according to the 3 levels of difficulty.

Gr.	level of difficulty	Rod	Ice-lolly	Glass
A	1	35%	40%	10%
	2	0	25%	10%
	3	0	10%	10%
B	1	75%	85%	80%
	2	70%	90%	65%
	3	60%	75%	55%
C	1	96%	96%	90%
	2	100%	96%	96%
	3	100%	93%	96%







Table 9.3 demonstrates the predominance of group B subjects over group A subjects and of group C subjects over group A subjects in all three tasks, at all levels of difficulty. Subjects of group C did significantly better than group B subjects at all levels of difficulty of the rod seriation task and at level 2 and level 3 of the Glass seriation task. No significant difference was found between the performance of these two groups of subjects for the Ice-lolly picture seriation task. The overall picture obtained by an analysis of the results expressed in Table 9.2 and Table 9.3 shows a developmental evolution between all three groups of subjects except for the Ice-lolly seriation task where both group B and group C subjects obtained a fairly high score.

This result can be explained along the hypothesis proposed in the introduction of this chapter, i.e. a picture seriation task might be an easier task for a child than the classical rod seriation task. Indeed results showed that older subjects (group C) had an advantage over the younger ones (group B) for the rod seriation task but not with the Ice-lolly picture seriation task.

Concerning the Glass picture seriation task for which group C subjects obtained a significantly higher score than group B subjects, this can be explained by the younger subjects' difficulty in coping with simultaneous interactions between elements of each frame as was also demonstrated in chapter 6.

A further analysis carried out on results obtained to the two types of seriation tasks showed that generally subjects who succeeded in the rod seriation task also succeeded in the picture seriation task (only one subject failed in one of the picture seriation task). This result might indicate that a correlation exists

between the two types of tasks that is that if a child succeeds in a rod seriation task he should also succeed in the picture seriation task of the type presented in this test. However, the converse proposition is not true since some of the subjects who failed in the rod seriation task did succeed in the picture seriation task.

A fact which is also instructive and denies us the right to establish a true correlation between the two types of seriation tasks, is contained in the results obtained in the post-test presented in section 8.2. Indeed, 6 to 7 years old subjects who succeeded in the rod seriation task did not necessarily succeed with the complex seriation problem presented in section 8.2 (these subjects obtained a score of 100% for the rod seriation task compared to 60% for the picture seriation task).

Considering these facts, it appears quite impossible to predict subjects' performance with one type of task using their performance with the other type of seriation task as a predictive criteria, at least with subjects between 6 and 7 years old and for all types of picture seriation tasks.

In the next section, an inventory of the characteristic behaviors of subjects belonging to the three main age groups will be drawn. This inventory will provide a means to parallel children's development relative to two types of seriation tasks and point out any divergence.

#### Group A (4 to 5 year olds):

It has already been emphasized that young subjects had great difficulty in understanding instructions relative to the rod seriation task. Relative to the pre-test in which the left-right convention of a picture seriation was exemplified, 9 out of the 20 subjects



pointed at pictures in the order of occurrence of the events they portrayed.

Subjects who did order the three well differentiated rods ( $N=7$ ) did not relate these rods at the baseline. Group A subjects usually picked up rods from the table in no specific order but rather by proximity, there was no actual "selection" of the rods. Some subjects did try to produce seriations with a "decalage" at the upper extremity of the rods, but did not consider the size of the rods or the lower extremity of the rods e.g.



These subjects more mostly interested in the overall configuration of the series.

Concerning the picture seriation tasks, pictures were ordered by proximity as well, but some consideration was taken of the varying size of the changing elements (the juice in the glass and the size of the ice-lolly). Indeed many subjects tended to classify pictures in two categories: pictures representing "a little boy starting to eat his ice-lolly" and pictures representing a little boy finishing his ice-lolly". The intermediate steps between the beginning and the end of the portrayed activity did not appear to have much importance and this explains why these frames were mixed up or rejected from the series.

Sinclair's study on the child's acquisition of language and development of thought (described in section 1.2) showed that the correlation between the verbal descriptions of a seriation and the developmental stages of seriation was relatively good. Having divided these descriptions into four categories, Sinclair found that the first category of descriptions involved dividing rods into



two groups: big or small. Descriptions of the second category involved using three quantifiers: small, medium, big. GroupA subjects' justifications of their chosen order in the picture seriation tasks involved descriptions which could be classified in these two categories. Justifications of the first category were of this nature: "that's the start and that's the finish or he's got some, he's got none". Justifications of the second category were of this nature: "he's got more, almost none, he's finished or he starts, he starts to finish, he's finished or he starts, he eats, there's no more".

Some subjects however, did not appear to have grasped the purpose of the task, or understood the idea of continuity and could not find any adequate justification for their choice.

In the other picture seriation task (Glass), the order chosen by some subjects was more perceptual than logical i.e. pictures were ordered in the reverse direction but no adequate justification could be given. Subjects did perceive differences between frames but could not seriate frames to reproduce the continuity.

The main difference observed when comparing reactions to these two tasks is that young subjects considered size of elements in the picture seriation tasks while in the rod seriation task attention was rather concentrated on the general configuration of the series of rods. This reaction might be due to the young subject's misunderstanding of the rod seriation task and suggests that picture seriation might be more adaptable to the young child's understanding of a seriation problem.

#### GroupB (5 to 6 year olds):

GroupB subjects did significantly better in the two types of seriation tasks than their younger companions. However, the same

categories of errors recorded with groupA subjects were present in these subjects' protocols for the rod seriation task. Many subjects were satisfied with seriations offering a perceptual resemblance to a true seriation. Nevertheless, they were asked to reconsider their series in terms of the size of the rods; many subjects could in a trial and error fashion, correct their order of rods. This procedure could however, become tedious when subjects were asked to intercalate the five remaining rods to the already ordered set of rods, their strategy not being very systematic.

Errors made with the Ice-lolly seriation task (third level of difficulty) involved interchanging frames. Relative to the Glass seriation task, some subjects reversed the order of the series (i.e. they started the series with frame F). When time came for these subjects to justify their choice of sequence and when they were asked to describe the activity portrayed in the sequence, many subjects spontaneously reordered their sequence in the adequate order.

As did groupA subjects with picture seriations of the third level of difficulty, many groupB subjects also dichotomised pictures using the size criteria (e.g. "these come first cause the're full, these go last cause the're not full").

#### GroupC (6 to 8 year olds):

Subjects between 6 and 8 years old were generally competent in completing the tasks they were asked to fulfill. The few errors recorded were generally due to inattention and were quickly corrected. Concerning the rod seriation task (third level of difficulty), subjects selected the correct rods to intercalate within their first seriation. Some of these subjects proceeded by measuring the selected rod with the one besides which they were going to place it. Some subjects



ordered rods side by side in the following manner



making sure the decalage was even at both the upper and lower extremities of the row. Other subjects preferred standing the rods up in a row and some other subjects piled them up, all in order. Most subjects started their series with the longest rod rather than with the smallest one. This particular order was also favored by younger subjects. The ordering procedure described above corresponds to the Stage IV procedure described by Piaget, i.e. to the stage at which a child has mastered the operation of seriation.

Concerning instructions given to these subjects, most of them understood the meaning of "setting rods in order of size". As far as the picture seriation task is concerned, the few errors recorded were errors of inattention for which subjects between 6 and 7 years old were responsible, 7 to 8 year olds having obtained the maximum score in all three tasks at all three levels of difficulty.

#### Developmental evolution of children in two types of seriation tasks:

This study showed a clear evolution in performance between the youngest subjects' performance (4 year olds) and the oldest subjects' performance (8;5 year olds) in most seriation tasks except for the Ice-lolly picture seriation task, where no significant difference in performance was found between groupB and groupC subjects. The evolution between groupA subjects and groupB subjects was characterised by a better understanding of the rod seriation task by the older subjects. Indeed 4 year olds did not generally appear to grasp the purpose of the task and if strict instructions (Piaget's instructions) had been given, the score would probably have been nil.



While very little interest was shown for the size cue by 4 year olds, 5 year olds did attend more to this cue even though many subjects still concentrated on the general configuration of a series rather than on the true size of individual rods. Concerning the evolution of groupA and groupB subjects with the picture seriation tasks, groupB subjects were more concerned with size differences between individual frames than groupA subjects who divided pictures in two groups: the ones representing the "not finished ice-lolly and the finished one" or the "full glass and the not full glass".

The evolution from the groupB to the groupC level of performance in the rod seriation task is characterised by a quicker understanding of the task, a more direct and precise selection of proper rods as opposed to the trial and error strategy of some of the younger subjects. Concerning the Ice-lolly picture seriation task, results showed an equal understanding of the task by the two groups of subjects, the gross difference in score being due to a lack of attention of the younger subjects who occasionally interchanged frames.

The absence of a significant difference in performance of the two groups concerning the Ice-lolly picture seriation task was justified earlier. It indeed appears that the concept of order expressed in a picture seriation task is easier to grasp for young children than the one expressed in the classical seriation task.

Concerning the Glass picture seriation task, the main difference recorded between the two groups is that the younger subjects demonstrate a difficulty in coordinating two simultaneous size transformations within the sequence of represented moments and in that too little attention is given to the differences between frames.

Developmental description of the rod seriation task in the context of Piaget's theory and according to Young's production system (P.S)

In Piaget's terms (1968b), subjects' performance could be described as belonging to the following stages:

GroupA subjects' performance generally corresponds to Stage I and Stage II descriptions of the rod seriation task.

Stage I represents subjects who do not attempt seriation as such.

Stage II c) subjects only seriate considering the upper extremity of the rods; no attention is given to the horizontal baseline.

Stage II d) "roof-type" seriations (sériation en toit) are also produced.

GroupB subjects behaved either as described in Stage II (b),c),d)), Stage III or Stage IV of the seriation task.

Stage IIb) seriations involve series of trios incoordinated between themselves (a big rod, a medium one, a small one).

Stage III is represented by trial and error success with a difficulty in intercalating remaining rods.

Stage IV is represented by systematic seriations and an ability to intercalate rods in their proper position.

GroupC subjects generally behaved as in Stage IV (see above description).

Now, if children's performance is described according to Young's P.S. and an inventory of the rules subjects followed to respond to the task is compiled, the following strategies were adopted.

Let us say first that each rule in the P.S. is regarded as belonging to one of three components: 1. selection, 2. evaluation, 3. correction or placement.



Here is a diagram presented by Young on p.199 of his thesis (1973):

#### Selection

- Proximate: blocks are chosen in an order unrelated to their size.
- Weak: some account is taken of size, but the correct block is not reliably chosen.
- Suitable: the correct block is usually picked.

#### Evaluation

- None: any block is accepted.
- Monotonic: a block is accepted provided the line remains in order.
- Precise: only the correct block is accepted.

#### Correction

- reject: an unacceptable block is simply returned to the pool.
- Weak: limited means are available for correcting a wrongly placed block.
- Strong: a block can usually be put where it belongs.

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GroupA subjects generally proceeded by proximate selection and accepted any block in the series. There was no effort made to correct their series.

GroupB subjects who made errors behaved as described in Weak Selection and Weak Correction.

GroupC subjects behaved in a Suitable, Precise, and Strong way.

Piaget's and Young's descriptions of children's performance vary in their level of generality. Indeed one notices that the general rules marked by Young can be applied to all types of behaviors while Piaget's numerous stages have not been exemplified in the data obtained in our rod seriation experiment. According to Young,



the force of his P.S. is that it can cope with variations of the basic task. In examining results obtained with the first two levels of the rod seriation task (3 rods), it indeed was quite difficult to find in Piaget's descriptions of Stages the evolution of subjects' performance. For instance none of the four types of descriptions of Stage II applied to the data obtained with the three rod seriatiions. On the other hand, many 4 year olds' behavior with these two seriatiions (3 rods) could easily be classified according to the first two components described in Young's diagram presented earlier (i.e. Selection: proximate, Evaluation: none). However, Piaget's system is more detailed and precise when results to more complex tasks are analysed. Young concedes that his P.S.s have been lacking something in detail and precision. However, his more dynamic approach of the child's behavior with rod seriation tasks remains quite interesting and promising.

#### Picture seriation tasks versus rod seriation tasks:

An analysis of groupB subjects' performance demonstrated that subjects were more interested in the configuration of series of rods than in the difference in size of rods within a group. In picture seriation tasks, the decisive criteria used in organising pictures into a particular order is the general context underlying a sequence of events.

An analogy can be made between the role of configuration in a rod seriation task and the role of context in a picture seriation task. Indeed both configuration and context are used as ordering criteria. However, this analogy between the two seriation procedures has limited implications. Indeed while the overall configuration

of a rod series can be grasped fairly quickly (young children can reproduce graphically series of lines in increasing or decreasing order at an early stage of development), extracting the context underlying a series of pictures cannot always be done so quickly. One of the reasons which justifies a deeper analysis in picture seriation tasks is that the transformations represented in each frame are not always of the same "size" or of the same nature (or dimension). Moreover they can involve the need for co-ordinations of simultaneous interactions within each frame as well as the necessity to account for the presence of new elements in one or more frames. The complexity of a picture series is almost unlimited while constructing a series of rods implies using the same ordering criteria over and over (i.e. size). The evidence recorded in previous chapters has time and again exemplified the variety and the extent of the complexity of picture seriation tasks.

The analysis of subjects' procedures to order rods and pictures in the context of the present experiment revealed that in the case of rod seriation, subjects accepted the "good form" (configuration) of a series as the criteria which should be satisfied in producing a proper seriation. In the picture seriation task, subjects were not so much interested in that for example, the level of juice appeared to increase regularly in the glass (producing in this way a good form), but rather that a picture representing the beginning or the end of the event be placed at the beginning or the end of the row.

The difference in the categories of errors recorded in the two types of tasks are revealing on the child's strategies and understanding of the tasks. Indeed, the ordering criteria to be



used in the picture seriation task was much better understood by subjects than the ordering criteria to be used in the rod seriation task. Children understood the general "direction" of the picture series (i.e. the Ice-lolly picture seriation should start with a complete ice-lolly decreasing in size as the progression advanced) while in the rod seriation tasks, many subjects were not concerned with beginning the series with a particular rod or ordering rods by size, but rather with giving their series a perceptually acceptable "form". In the picture seriation task, a lot of significance is attached to the task of choosing the frame representing the beginning of the sequence which is not the case for the rod seriation task.

It therefore seems that pictures are interpreted in terms of their dynamic content and once the general context has been extracted from the series, pictures which are chosen as representing the beginning and the end of the sequence carry a lot of weight in the child's mind. This would explain why in previous experiments the first and last portrayed moments of an event were often properly seriated while the intermediate ones were often excluded or interchanged in the series. The dimension of time seems to have the priority over the spatial dimension in picture seriation tasks at least in the first phase of the ordering procedure i.e. when the context is extracted from the picture series.

The difference in criteria used to seriate pictures and rods (i.e. size in the case of rod seriation and position in time of a represented event in the case of picture seriation), the variety in the classes of transformations represented in picture seriations (one class of transformation is used in rod seriations: size), the number and the complexity of interactions represented in



strip-cartoons are all factors which make the task of comparing rod seriations and picture seriations very difficult.

Consequently, one must realise that the study of the concept of order as expressed in picture seriation tasks implies a very different approach than the one used in rod seriation tasks. However, at a higher cognitive level, more general comparisons could be carried out between the two seriation tasks, but at that level of discussion, almost any type of tasks could be compared since Piaget's developmental theory remains unchanging whatever problem he studies.

#### Conclusion:

The present study showed an evolution in the performance of 4 to 8 years old children. The youngest children's problem was to understand the purpose of the tasks and it has been suggested earlier that special care should be taken to facilitate the young child's comprehension of the rod seriation task. Results have shown that each successive group of subjects (successive in terms of age) did significantly better than the younger one for all tasks except for the Ice-lolly picture situation. No significant difference was found between the performance of group B and group C subjects. This result had been predicted on the grounds that the familiarity and the logic inherent to strip-cartoons would facilitate the child's understanding of the task as well as the seriating task itself. The rod seriation task, which did not represent a familiar and meaningful event for the child would therefore be more difficult.

A comparison between subjects' strategies and errors in the two seriation tasks revealed that children do not use the same criteria to evaluate the position of pictures and rods in a series.

Pictures are interpreted in terms of their dynamic content and as representing particular moments in the sequence.

One difference and advantage of a picture seriation task such as Ice-lolly over a rod seriation task is that pictures are not interpreted only as varying in size but as representing a familiar event the unfolding of which is known by the child. A picture is interpreted also in terms of the moment it represents in the sequence. It can be invested with a variety of properties while rods can only be interpreted in terms of size. Pictures have a personal reference for the child while rods exist only in terms of their size.

In spite of all these advantages, a picture seriation task can be complexified and the problems involved multiplied so that at one stage a rod seriation task becomes relatively easier to perform than a picture seriation task.

Consequently one cannot consider the child's ability to solve one type of picture seriation problem as a guaranty of success for all picture situations. This has been fully demonstrated in previous experiments.



## CHAPTER 10

Conclusion

The first aim of this chapter is to see how far we have come in completing the task set at the beginning of this investigation i.e. in answering the questions put forward on p. 36 of the introduction. These questions concerned the evaluation of the child's ability to interpret strip-cartoons and the evolution of the acquisition of the concept of order measured by both picture and rod seriation tasks.

A succinct way to fulfill this task is to draw a record of subjects' assets and deficits relative to the various tasks they have been asked to perform. A first step in completing this task will be taken in section 10.1 where a summary of findings will be presented.

In the introduction to this study, a Piagetian profile of the preoperational child was drawn (section 1.1). It was, however, difficult at that point to predict how preoperational children would behave in strip-cartoon interpretation tasks on the basis of this profile alone.

Now that some information has been acquired on children's behavior in this context, it becomes possible to provide a new profile which this time will emphasise children's attitude towards picture seriation tasks and their power of reasoning. This profile will be presented in section 10.2.

Section 1.4 of this study reported some of Piaget's findings on the concept of time, namely on the child's ability to order series of pictures. It was then argued that on the basis of Piaget's later description of the preoperational child (1947 and 1970 compared



with the 1925 studies), on N. Van Den Bogaert Rombouts' evidence and on the evidence already collected from pilot studies that subjects should perform at a higher level than the level described by Piaget in 1925. In section 10.3 a comparison between Piaget's findings (1925) which to our knowledge have not been revised, and the findings gathered in this investigation will be carried out.

In the following section, section 10.4, an outline of subjects' linguistic justifications of sequences of events will be presented and compared to the evidence put forward in section 1.2 of this study.

In sections 1.3 and 1.4 the question of the child's ability to interpret various classes of transformations was discussed. It appeared then, that it was very difficult to predict children's behavior with various classes of transformations without taking into account the material and procedures used to collect the data. The purpose of section 10.5 is to see how this problem is related to strip-cartoon interpretation.

The last section, section 10.6 will be concerned with the extensions and limitations of our method of research i.e. strip-cartoon interpretation. This method will be discussed in reference to the classical method of studying the child's acquisition of the concept of order i.e. the rod seriation task.

#### 10.1 Summary:

1- Results reported in chapter 4 showed that 86% of subjects could relate two pictures in time with proper justifications. However, many of these subjects were influenced by the order of presentation of the two-picture series. Indeed, many subjects tended to choose the first presented picture as the beginning of the sequence.

The interesting fact which emerged from this study was the ability of these subjects to produce quite complex justifications for the choice of the less plausible sequence of portrayed events.

2- Chapter 5 experiments presented subjects with tasks of an increasing degree of difficulty. In one condition where subjects were asked to decide which of two pictures preceded or followed a middle one, scores indicated that subjects could cope very well with this problem (the average score was 90%). In a second condition, another group of subjects were asked to decide on the order of the same three pictures, but were given no information on the identity of the middle picture. These subjects were less apt to perceive the continuity of the three pictured events. It was noticed that they generally had less difficulty in coping with quantitative and positional classes of transformations. However, in particular contexts these classes of transformations brought about problematic situations especially in a case where the background of the three pictures lacked uniformity.

Findings obtained with sets of pictures presented in the following condition (4 and 5 picture sets) demonstrated that children found it particularly difficult to organise sets of pictures representing simultaneous interactions between elements. This experiment also indicated that even though subjects could figure out the underlying context of a sequence of pictured events they still made seriation errors which they could, however, correct.

3- In the next series of experiments (chapter 6), an effort was made to minimise the deficit showed by subjects who did not pick up the context underlying a sequence of pictured moments. Subjects were presented with "easy-context" picture series (section 6.1) or made aware of the story corresponding to each series of pictures



(section 6.2). Since results reported in chapter 5 showed that subjects still made errors when they did grasp the context, it was expected that under these new optimal conditions, many of them would still make errors.

Subjects presented with the "easy-context" experiment did grasp the context underlying sequences of events but tended to overlook details and confuse the order of some of the pictures. Results have shown that it is not before the age of 7 that children can consistently cope with this type of task, i.e. distinguishing frames differing by details.

In the experiment reported in section 6.2 subjects were firstly presented with series of pictures without the corresponding story (condition 1) before being presented with the story (condition 2). An interesting result was elicited by the procedure used in this experiment. It was found that subjects who could grasp the context underlying a sequence of events but who still confused the order of some of the frames corrected their sequence after having heard the story. This behavior suggested that hearing the story might give the child the opportunity to reconsider his first choice and help him to concentrate on specific cues rather than simply grouping similar pictures. Subjects who did not cope with sets of pictures in the first condition tended to do as poorly even after having heard the story. This result suggested that young subjects might not benefit from being told stories in such complex situations.

Since these results showed that children tended to overlook differences between similar frames, that they had difficulty in following simultaneous interactions between elements and in grasping the context underlying series of pictured events, another experiment



was set up that would minimise these difficulties (this experiment was reported in section 6.4). Subjects were told the story corresponding to the sequence of pictured events and presented with well differentiated frames representing straightforward actions. Results obtained in this section (i.e. 88% of success compared with 67% in section 6.2) agreed with the prediction that children would be able to match a story with a sequence of pictured events provided that pictures were well differentiated and represented simple straightforward actions.

4- In chapter 8, subjects were given the task of ordering 11 pictures and provided with an incomplete story, which implies that they were not allowed to make a one-to-one correspondence between events mentioned in the story (6 events) and pictures (11 events). They would therefore have to infer from the provided information the position of the "extra" pictures (5 pictures). This task proved very difficult since only 25% of subjects managed the seriation task in the first instance (with some help other subjects managed to produce the proper sequence). Subjects who did succeed in this task were all over 6 years of age. A post-test revealed that it was not before the age of 7 years old that subjects responded consistently and correctly to this particular seriation task.

5- One type of experiment which proved quite instructive in the evaluation of children's potentiality in interpreting strip-cartoons was the drawing experiment reported in chapter 7. Indeed it was found that children had a good understanding of the correspondence between spatial and temporal series. Findings also demonstrated that since subjects reproduced the salient differences between the pictured events, the problem in the preceding seriation tasks had

been a problem of "actual detection" of differences rather than a problem of "potential understanding" of the differences. Findings in the drawing task parallel the ones recorded in the experiment reported in section 6.4 by suggesting that subjects can cope better with well differentiated frames than with frames sharing numerous common features. Such frames were considered as containing redundant information for children.

6- The developmental study carried out in chapter 9 established a clearer portrait of the child's acquisition of the operation of seriation. Indeed a significant difference between the performance of subjects belonging to each age group (i.e. 4-5 year olds, 5-6 year olds, 6-8 year olds) appeared for most tasks except the Ice-lolly picture set for which this difference was not significant. This result was explained to some extent in the conclusion of the preceding chapter. Let us say briefly that subjects do not use the same criteria and strategies to seriate pictures and rods at least at an early stage of development. Older children carry out more and more of their problem-solving internally so it becomes more difficult to be explicit on the procedures they use in taking decisions.

An analysis of both types of seriation tasks showed that it was difficult to conduct a close comparison between these two tasks. One of the main reasons for this problem is that picture seriation tasks represent a variety of problem-solving situations while rod seriation tasks are limited to measuring the child's transitive inference capacity (in Piaget's terms) and his ability to differentiate between lengths of rods.



## 10.2 The preoperational child's profile in the context of strip-cartoon interpretation tasks and rod seriation tasks.

In section 1.1 the preoperational child was characterised as functioning by trial and error strategies. In the course of this study, time and again it was noticed that subjects used trial and error strategies. What characterised the younger subjects' approach to a task was the unthinking way in which they responded to instructions. Shortly after they had grasped the meaning of the instructions, they produced a response which was often inadequate. Their responses sounded more like questions than answers. If children were encouraged to reconsider their answer or questioned a little about their first response they very often responded correctly. It was quite interesting to notice the difference in reaction between the younger and older subjects; the latter ones were much more careful and steadier than the younger subjects. Older subjects spent more time analysing sets of pictures before responding and their response was firmer and better justified than younger subjects' response.

Concerning the preoperational child's power of reasoning, subjects' answers revealed their ability to provide logical justifications for their choice of sequences as well as their ability to make inferences. However, these abilities were sometimes challenged in difficult situations. Results obtained in the experiment reported in section 5.1 (ordering three pictures, the second picture being designated to the child) and in section 5.4 (ordering sets of four and five pictures) revealed the incoherence of subjects' justifications. Indeed 22% of mistakes in section 5.1 and 29% of mistakes in section 5.4 were "illogical continuity" type errors. In the experiment reported in section 5.1, subjects behaved as if they took for granted the



continuity of the three-picture sets. However, since they had not really understood the continuity of the sequence, they proposed an artificial story which made no sense. Many subjects knew very well that their stories were incoherent, but they preferred giving a wrong answer than no answer at all.

Concerning the preoperational child's capacity to deduct motion from static pictures and to predict future events from a pictured scene, experiments reported in chapter 2 confirmed this ability. The fairly high scores obtained in chapter 4 (86% of success) and in chapter 5, section 5.1 and 5.2 (90% and 70%) suggest that children can infer from the information presented in pictures the order of the events they represent. However, findings reported in chapter 8 showed that subjects did not use the information provided by the story and the pictures to infer the position of pictures representing events which had not been referred to in the story. It is only after the age of 7 that success with this picture situation became more consistent. These results indicate once again that the child's ability to make inferences needs to develop in order to satisfy the demands of problem-solving situations of various levels of complexity.

A comparison between the results obtained with the seriation problems presented in chapter 9 and the one presented in chapter 8 (section 8.2) have shown that subjects who can seriate a series of ten rods and who can intercalate within an already constructed series a number of extra rods could not necessarily succeed with the comparable picture seriation task presented in chapter 8. Indeed in the rod seriation task these subjects were, according to Piaget, capable of making transitive inferences while in the picture seriation task,

the power of this logical structure was not sufficient to fulfill all the requirements of the seriation task.

All in all, this study has shown that a young child can manage fairly well with cartoons representing a straightforward event, but evidence has demonstrated that until the age of 7, he had a lot of difficulty to combine multi-dimensional and multiple transformations represented in the same sequence.

### 10.3 Piaget's 1925 study on the concept of time.

In 1925 Piaget claimed that it was not before the age of 8 years old that children could co-ordinate series of pictures in coherent wholes. A look at the material presented to Piaget's subjects might account for the low scores obtained in the seriation task since results obtained in this study demonstrated that children could co-ordinate series of pictures to a certain extent.

Piaget had argued that children could not identify two pictures as representing the same story. Results obtained throughout this investigation demonstrated that children were very much able to do so.

Piaget had also claimed in 1925 that children were unable to understand the left-right order convention, i.e. the order in which pictures were to follow in the sequence. Pilot studies demonstrated that children could be taught this convention. An analysis of subjects' responses also revealed that subjects had an understanding of the spatial order in which they lined-up pictures.

Even though subjects in this investigation did generally perform at a higher level than Piaget's subjects, some of the deficiencies outlined by Piaget were also noticed with younger subjects.

For instance, younger subjects found it difficult to reorder a series of pictures if asked to reconsider their choice. They



considered their first choice as the most plausible one. Young subjects spent very little time making hypotheses concerning the most plausible order of pictures. Indeed results obtained in chapter 4 (the first picture effect) showed that many of them preferred justifying their first choice of sequence rather than investigating the possibility of another one.

All in all, some of the deficiencies pointed out by Piaget were also noticed in the course of this investigation, but by no means were characteristic of all subjects. Under particular circumstances, such as the ones created in section 6.1 (i.e. the easy-context condition in which set 17-18-19-20-21-22 representing Rupert opening up a parcel was ordered correctly by 70% of subjects) and in section 6.4 (i.e. the well differentiated frames experiment obtained a score of 88%) as well as in the drawing condition reported in chapter 7, children demonstrated a very acceptable level of performance and an understanding of the seriation task.

#### 10.4 Justifications of sequences of events.

An analysis of subjects' linguistic justifications of sequences of events agrees with findings on children's linguistic habits referred to in section 1.2 of the introduction. One can recall from Cromer's and Clark's studies (Cromer, 1968 and Clark, 1968-1970) that children tend to retain the actual order of events in their spontaneous speech rather than use expressions such as "before" and "after". Indeed, Ferreiro and Sinclair (1971) noticed that children found it difficult to use such temporal indicators.

When justifying the order of a sequence of events the majority of subjects were content with juxtaposed descriptions of pictures in the order in which these represented events occurred



(e.g. the order of set 25-26-27 presented in section 5.1 is justified as such: "Rupert's kicked the ball and it's gone far away and it went down and he can't get it").

Other subjects include a time dimension in their justification by using different verb tenses (e.g. the order of set 22-23-24 presented in section 5.1 is justified as such: "She's going to eat a chicken, there she has and there she's finished").

Occasionally subjects used "time words" such as "then", "yet", "just", "first", "second", "next", "how". Another form of justification was the negation. For instance a child would say: "He's near here and he's not near there" or "He's dead here and he's not dead there". In rare cases children used comparatives such as nearer, closer, further.

The linguistic justifications of picture situations presented in chapter 9 showed that some children tended to divide a series of pictures (containing six frames) in two or three groups of major moments. These privileged moments corresponded to the beginning and the end of the event. Sinclair (cf. section 1.2) who has conducted an analysis of children's linguistic behavior when seriating rods, also noticed that at a certain stage of development children did tend to classify rods as either big or small before they actually used comparatives.

#### 10.5 Classes of transformations in strip-cartoon interpretation.

Results obtained in section 5.2 and 5.3 of this study did not provide a definite answer to the question posed at the beginning of chapter 5 i.e. on the order of difficulty of various classes of transformations. The controversial results collected showed that one cannot consider a particular class of transformation independently of the context in which it takes place. Indeed it was found that the same classes of transformations: quantitative and positional changes obtained the highest and lowest scores. A detailed analysis of sets of pictures concerned revealed that the familiarity of the elements undergoing the change, the pictorial context in which the change was taking place and the uniformity of the background in each frame of the set were all factors which could play a role in the child's comprehension of different classes of transformations. However, results suggested that with familiar elements presented in a meaningful context and in a uniform background quantitative and positional transformations were the ones easiest to decode. The success obtained to a picture seriation task also depended on the child's ability to differentiate between similar frames and on his ability to cope with frames portraying simultaneous interactions between elements (this was demonstrated in the experiments reported in chapters 6 and 9).



#### 10.6 Extensions and limitations of strip-cartoons.

This study has attempted to answer a number of questions concerning the child's acquisition of operational thinking. The means chosen to assess the child's development was strip-cartoon interpretation. A variety of tasks of different levels of difficulty were presented to subjects so that one could appraise early acquisitions as well as children's response to more complex problem-solving situations. A comparison between a classical seriation problem (rod seriation task) was carried out and was used as a yard-stick against the picture seriation type of task which however, is a much more extensive measure of the child's seriation ability, of his development. Indeed, strip-cartoon interpretation goes much further than rod seriation; it can be used to study the child's comprehension of the concepts of space, time, number, the development of the multiplicative, causal and spatial logical structures. Applications of this method of study are numerous; indeed this method can be used to investigate children's linguistic habits, their memory span or their creativity. Unfortunately a number of interesting questions have been left out of this study but we have tried to consider as many aspects of the child's development as possible considering the usual constraints implied in such a research.

This study does not claim to be exhaustive and it does not pretend to have put forward a new theory of the child's development. Indeed many questions remain to be answered before one can establish a list of the variables which influence the child's behavior (or before one can circumscribe the problem of strip-cartoon interpretation) and before one can reach the train of gear-wheels which sets the child's mind going.



However, the method used to inquire more deeply in the cognitive domain has opened up new dimensions of the child's mind and offered a new way of conceiving and testing the child's comprehension of the concept of order. Indeed most of the research carried out on the development of the concept of order has been done with tasks involving spatial series. In the case of picture seriation tasks, the problem is of a much more dynamic nature and involves not only spatial but temporal order. The multi-dimensional nature of the problem provides a field of study which is not only rich in the variety of the dimensions of thought it embraces, but it provides a means of testing early acquisitions as well as later ones. Indeed this study has shown that very young children (4 year olds) can interpret pictures dynamically and generatively i.e. they have an understanding of the concept of order of events in time. The drawing experiment reported in chapter 7 has shown that children of 5 years old could construct their own series of pictures in the proper spatial order respecting the order of succession of events something they found difficult to do when a particular set of pictures was imposed upon them (cf. chapter 6). The problem of the young child seems to be a problem of adaptation to the particular constraints of testing situations rather than an inability to conceive of events or pictures in terms of spatial and temporal series.

On the other hand another experiment has shown that older subjects (6 years old) who could cope with the operation of seriation as measured by a rod seriation task (e.g. ordering 10 rods and intercalating extra ones) obtained a much lower score with a picture seriation task involving the intercalation of extra pictures (cf. chapter 8). This result is an example of the complexity which picture seriation tasks can reach in comparison to rod seriation

tasks. Indeed, as it was mentioned before, picture seriation tasks have the possibility of measuring the child's later acquisition of the concept of order owing to the extensive range of problem-solving situations it provides.

From such a perspective, the picture seriation task has an advantage over the classical measure of the child's acquisition of the concept of order, but as a comparative measure it is difficult to use for reasons discussed in chapter 9. One of these reasons is that strip-cartoon interpretation is not strictly a measure of the notion of order, but of numerous dimensions of the child's thought.

Another point which was made quite strongly in chapter 9 is that children have a better understanding of the principle of seriation with picture seriation tasks than with rod seriation tasks. Indeed, a whole section of chapter 9 was devoted to demonstrating how poorly the classical type of instructions (Piaget's formulation) used with rod seriation tasks are understood by the younger subjects. Moreover it is also believed that the earlier success obtained with picture seriation tasks (of a certain level of difficulty) depended on the type of strategies used by subjects. It would seem that their interpretation of picture series along the dimension of time increases their chances of properly ordering a picture series. The crux of the matter might just be that it is easier for a child to understand temporal series than spatial series because he knows that events follow in time in an irrevocable way while spatial order is often very arbitrary. An illustration of this point can be made by a quick analysis of subjects' interpretation of the Ice-lolly picture situation. In this picture situation, pictures were interpreted not only as undergoing a change of size but as



representing particular "states of the size transformation" i.e. a picture is compared to the others in terms of its size and in terms of the "moment" it represents in the sequence. The fact that the child knows that as one eats an ice-lolly it decreases in size helps him to seriate the sequence of pictures in the proper order. This type of problem certainly gives the child a better chance of expressing his understanding of the principle of seriation.

All in all strip-cartoon interpretation provides numerous advantages for investigators concerned with the cognitive development of children. The strip-cartoon presented in exergue at the very beginning of the dissertation can give an idea of the order of complexity which strip-cartoon interpretation can reach and of the variety of problem-solving situations which can be created.

We believe that a study of the concept of order in the context of strip-cartoon interpretation does better justice to the child's potentialities and competence.



### Appendix 1

Pilot-test with 4 to 5 years old subjects using a three picture seriation task.

#### Introduction:

Subjects between 4 and 5 years old were tested with a three picture seriation task in order to assess their ability to respond to the task.

#### Material:

Sets 1-2-3, 13-14-15 and 16-17-18 (illustrated on pp. 95 and 96) were presented to subjects. These sets have obtained the highest scores recorded in Table 5.2.3 (cf. p. 121) for a three picture seriation task.

#### Subjects:

Twenty subjects between the ages of 4 and 5 years old (4;1-4;11, the mean age being 4;6) were presented with the three picture seriation task. They attended a pre-school class belonging to a lower and middle class district.

#### Procedure:

These subjects were first presented with a pre-test (described on p. 12). The purpose of this pre-test was to teach subjects the left-right convention of ordering pictures. Subjects were then presented with the 3 sets of pictures and asked to seriate pictures in the adequate order i.e. the one corresponding to the unfolding of the event. They were also asked to justify their choice of order. (The procedure described in section 5.2 was also used in this pilot-test.)

Results:

The pre-test was correctly performed by nine subjects out of the twenty subjects tested. Many subjects were unable to point out pictures in the order of occurrence of the events they represented.

The percentage of success obtained to these three picture seriation tasks was 8% and no single child ordered correctly more than one of the three seriation tasks. Most subjects could not justify their choice or were very inconsistent in their choice, accepting any proposition from the experimenter.

Conclusion:

The unreliability of subjects' answers suggested that older subjects should be tested in the remaining experiments.



Appendix 2

Lloyd (1974, p. 104) found that in a communication task where children were asked to differentiate pictures as same or different (not/same) the number of differences between pictures was not per se a significant factor. Even though 64% of errors occurred when there was a single difference, he found that the "dimension" of the element which changed appeared to have more impact on the child's ability to perceive the difference than the number of differences itself.

Lloyd's results show the influence of both the "size" of the difference and the "saliency" of the differences. It is too early at this point of the study to make any claims as far as the nature of features which might be more salient than others for children. In Lloyd's experiment colour was the feature which was picked up with the most ease (colour of the bear's coat), however, it was found in a pilot study where sets of strip-cartoons were to be compared, that children had the most difficulty in distinguishing between sets in which the distinctive feature was colour. It therefore appears that the saliency of certain features relative to others cannot be "objectified" and depends greatly on the context in which it is studied.



Appendix 3A post-test with 6 to 8 years old subjects.

In order to obtain more precise information on the age at which children can solve this type of problem a post-test was carried out. Twenty nine subjects were therefore tested with sets 1-2-3-4-5 and 6-7-8-9-10.

Table 6.1.2 Percentage of success obtained to the two sets of pictures.

set	scores 6-7	scores 7-8
1-2-3-4-5	80% (12/15)	100% (14/14)
6-7-8-9-10	40% (6/15)	92% (13/14)

Results presented in Table 6.1.2 show that it is not before the age of 7 that children can master this type of task i.e. they can deal with picture situations involving a fairly sharp discrimination between similar frames.

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